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Hygiene.

BY ALFRED CARPENTER, M.D., M.R.C P. (LOND.),

Chairman of the Council of the Sanitary Institute.

IT should be known to our readers that the Science and Art Department at South Kensington has introduced into its list the subject of hygiene. Examinations will be held upon hygiene about the same time in the year as those connected with the other subjects which are in the list published by the Department.

We are of opinion that this is an important step in the right direction; that grants from the State exchequer for this purpose will be repaid to the country a thousandfold if it leads to the popularisation of the truth regarding the general health of the people. To assist this object, and to place in the hands of the teachers of the country a means whereby they may prepare students for this examination, we propose to supplement the work which has been already done in that direction by some further instructions upon '*General Hygiene.*' If our readers will refer to the observations which have been made in '*School Hygiene*,' '*School Surgery*,' and the '*Teacher's Health*,' and follow them up by carefully considering the additions which will be supplemented in this and the succeeding numbers, there will be information sufficient to enable students who can fairly grasp the subjects treated of, to pass the examination with credit to themselves and their school. It should be known that no payments will be made upon the results of the instruction of pupils in this subject who have not passed the examinations of the Department in Animal Physiology.

We propose to consider *seriatim* the main points in general 'hygiene' which have been omitted from former volumes, and which are put forth in the syllabus which has been issued by the Department as necessary for candidates to know. We propose to take them somewhat in the following order:—

(1) *Food and its Adulterations*, including classification; economical and wasteful diets, and calculations of diets, etc.

(2) *Water and Beverages.*—This will include different kinds of waters; sources of contamination; filters, constant and intermittent service; fermented and unfermented drinks; aerated waters and other beverages, such as tea, coffee, cocoa, etc., etc.

(3) *Examination of Air.*—Microscopical and chemical; the general changes which take place in air consequent upon meteorological conditions; its deleterious conditions; the quantity required for each person, etc.

(4) *Removal of Waste and Impurities.*—Principles of ventilation, natural and artificial; antiseptics, deodorisers; cesspools, main sewers, traps, dry and wet methods of removal of sewage, etc., etc.

(5) *Shelter and Warming.*—Sufficiency for all; injurious clothing and modes of dressing; poisonous dyes; materials for construction of walls and roofs; foundations, floors, dangerous papers and other wall coverings; fireplaces, stoves, and grates, smoke abatement, products of combustion, radiation, warming by hot air and water, etc.

(6) *Local Meteorological Conditions.*—Elevation, wind, rain, moisture, ozone, etc.

(7) *Personal Hygiene.*—Influence of age, sex, temperament, idiosyncrasy, heredity, etc.

(8) *Prevention of Disease.*—Consumption, scrofula, rickets, rheumatic fever, marsh diseases, endemics, epidemics, etc.

(9) *Nuisances.*

(10) *Vital Statistics.*

(11) *Sanitary Laws*, etc., etc.

In each of these subjects reference will be made to the best books which have been published for further information, so that a student anxious to go deeper into the study of each may be directed to the best sources of instruction with the least loss of time. In this way we hope to lay the foundation for a true knowledge of hygienic laws, by which the health of the people may be materially aided, and a great stride made towards the removal of disease from among the masses. It cannot be too generally known that nine-tenths of the common ailments to which people are daily subject are not absolute diseases, but are functional derangements consequent upon an interference with the proper and uncontaminated supply of air, water, or food, or else to a non-removal of *débris* from the curtilage of the body itself, or from its immediate neighbourhood. The resulting contaminations produce functional disturbances; nature rebels at the treatment to which the body is subject, and an explosion takes place; the intruding contamination or its result

is expelled, and the corporeal atmosphere purified. If these functional disturbances are of frequent occurrence, organic disease of one or more of the organs most generally implicated eventually arises; the individual becomes a confirmed invalid, and the whole community suffers more or less in consequence.

It will be shown in the chapter upon vital statistics how the incidence of disease affects the interests of the public generally. I will only just refer at this point of my work to the fact that there are large establishments in the country, in which children are brought up in general obedience to sanitary law, the inmates being orphans, or those having been deserted by their parents, or are the children of diseased people who cannot work for the support of their offspring, and in whom poverty and depraved habits have led to the production of much hereditary evil. In these establishments the mortality is not more than 2·5 per 1000, and fatal epidemics are almost unknown; whilst in other districts where the masses are crowded together, and hygienic laws disregarded, the mortality equals 40 to 50 per 1000, and scarcely half the children born attain to the age of five years. This single fact tells its own story, and proves how great must be the incidence of preventable diseases among the people.

This incidence is promoted by two distinct causes. First, the ignorance of the masses themselves respecting general hygiene, which ignorance leads them to ignore the evil effects of foul air, foul water, and adulterated and decomposing food, etc., etc., and of the consequent sloth and intemperance which results from and belongs to this state of ignorance. Secondly, the want of knowledge on the part of the persons appointed to remedy the evils which arise from the absence of proper drainage and water supply, and of other mischiefs which it is the duty of the municipal authority to prevent or remedy. The syllabus provided by the Science and Art Department at South Kensington will, if pressed by teachers upon the attention of the advanced pupils in the higher and even in elementary schools, do much to check the incidence of disease in general by providing a lever of knowledge upon all the foregoing points, whilst those who aspire to the offices of Inspectors of Nuisances and Local Surveyors to Sanitary Boards and Sanitary Aid Committees, ought to possess a good general knowledge upon sanitary subjects such as the syllabus provides. I would therefore impress upon teachers the duty of bringing this subject to the notice of their classes, and ask them to point out the advantages which will accrue to those who are seeking employment in the sanitary field, and the great benefit which will result from all candidates for office, if they not only obtain the certificate of the Science and Art Department upon this subject, but also present themselves for examination to the *Sanitary Institute of Great Britain.* This Institute grants diplomas to its successful candidates, and enrols them as Associates of the Institute. The position is one which it is very desirable that sanitary officers should possess, because it brings them into direct relationship with the first sanitarians of the day, and entitles them to the publications of the Institute, and to the privileges of the 'Parkes Museum.' This latter is an educational exhibition of the best sanitary appliances of the time; it was founded in memory of the late Dr. Parkes. It is at present established at 74a, Margaret Street, and to it the Associates of the Institute of Great Britain have free access. They can there study the apparatus which is best fitted for sanitary work, see for themselves the best sanitary appliances in action, and get information as to the successful competitions at the various sanitary exhibitions which are held almost every year in connection with the Congress of the Sanitary Institute.

I press the point of examination in hygiene upon the attention of my readers, because I believe that those who follow the lead thus pointed out will show themselves to be philanthropists in the real sense of the word, the distribution of benevolence without regard to sanitary knowledge having a tendency to pauperise the people.

How much evil has been done under the guise of philanthropy and benevolence! People have become shiftless because the necessity for exertion has not been allowed to exist long enough to call forth the powers of resistanoe which are dormant in the system, and have, therefore, remained undeveloped. Self-reliance is decreased in each individual, until a mass of helplessness results, which, when there is sudden occasion for exertion in the presence of dangerous epidemics or other diseases, leads to panic and all its horrible consequences. The cry is, something must be done, when a little common sense, foresight, and prudence would have averted the necessity for sudden energy, which is nearly always exerted in a wrong direction. A study of the laws of hygiene, if they be put into operation, does more to promote thrift and self-reliance, and to combat pauperism and crime, than any other study, not even excepting the principles of religion, because benevolence uncontrolled by strict justice does an immense amount of evil in the world, with which result obedience to hygienic law cannot be charged. Hygiene does not allow of the dogma of doing evil that good may come, whilst it inculcates the duty of considering our neighbour's interests equally with our own; and as cleanliness is next to godliness, it appears to me that they are in reality identical, and almost convertible terms, and that the latter cannot be truly followed unless the former is scrupulously obeyed. With these observations I commend hygiene to the study of my fellow-men, as based upon the true principles of piety and justice to all.

FOOD.

Food is taken for various reasons. We obtain 'force' out of food; animal warmth is produced by its agency, so are nerve energy, mechanical motion, vitality. These powers are all the consequences of actions which are kept up by food. Grove, in his 'Correlation of Physical Force,' has shown us how light, heat, electrical action, motion, and chemical affinity are convertible the one into the other, and Mayer gave us right views upon the 'Conservation of Force,' whilst Mr. Joule assessed it at a value by which all the imponderable agents dealt with by Mr. Grove, are brought into comparison with an equivalent. He shows us that a fall of 772 pounds of water from a height of one foot, gives an amount of heat sufficient to elevate the temperature of one pound of water to the extent of one degree Fahrenheit, or conversely the fall of one pound of water from a height of 772 feet produces the same result. We are able to assess the dynamic power of individual foods, to show how they act in conserving the force which they may contain, and to point out which are the best for special purposes or the special wants of the body.

It is true that in the living body there are influences at work which do not exist in non-living matter. It has been supposed that physical force may be overruled by the vital principle, but whether this is so or not, it is not antagonistic to the principle of that conservation of energy which evidently does take place in the construction of the human body, and which conservation is a part of the process always more or less in operation in the body in connection with the assimilation of food.

The force evolved by muscular action is derived from the material which has been taken in as food. This is mainly obtained from the vegetable kingdom in the first instance, and is produced by the conserved force of the sun's rays. The oxidation of those materials allows the 'conserved force' to manifest its presence by 'potential or actual energy,' according as this oxidation goes on, slowly or rapidly, whether by simple means or by the compound actions which are operating in a thousand different ways. So we have actual and immediate results produced, or supplies are rendered 'latent,' ready at hand as occasion may arise for the production of the various attributes and functions which are proper to the animal frame.

Life implies constant, incessant change. Oxidation implies waste, and waste products must be removed. Thus we have to consider the nature of food with especial reference to its waste products. The ingesta have a value according as the egesta are great or small, just as an ore is valuable according to the percentage of good metal which it contains; so, conversely, food is valuable according to the greater or less amount of *debris* which results from its use. We must therefore consider the constituent elements which food contains, and choose those which can best satisfy the requirements of life.

The most essential elements are carbon, hydrogen, oxygen, and nitrogen; then sulphur, phosphorus, chlorine, silicon, and the alkalies, and alkaline earths, with minute traces of some of the metals, as iron, manganese, etc. These are the main constituents of 'Alimentary Substances.'

These elements have been brought into combination by the agency of living organism, and cannot be produced by simple chemical agency, but they all contain certain alimentary principles, which give the value to each, and upon which classification depends.

(To be continued.)

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Friedrich Fröbel.

BY HIS PUPIL, HEINRICH HOFFMAN.

VIII.

That same loving hand which amidst the roar of cannon had united the three young men in close friendship, took good care that no vicissitudes of life should undo a work which was destined for a great future. Soon after the war they met again in Berlin, Middendorf and Langethal being both engaged as private tutors. Middendorf, who felt his whole being irresistibly drawn towards Fröbel, was for a time his fellow-lodger, and Langethal joined him in earnest studies of educational subjects under their respected guide and friend, whilst the hearts of the three were drawn closer and closer to each other.

However, in 1815 the trumpet again summoned all Germany to arms. The united friends once more tendered their services; but as the applications were so numerous, all public officers and all members of the teaching profession were exempted. That 'still, small voice' within him became louder and more imperative, and so, in consequence of a letter he received, Fröbel resigned his office, and left Berlin on the first of October, 1816. Why and whither nobody knew; he only left word with his friends that they should hear from him as soon as he could tell them of anything definite.

The battle of Leipzig had filled to overcrowding all the hospitals available. Fröbel's favourite brother Christoph, the minister of Griesheim, a small village near Ilmenau, had fallen a victim to typhus fever during his philanthropic labours among the unfortunate sufferers. The letter referred to was from his widow, who asked for advice and assistance in the education of her three sons. Such an appeal was irresistible, and at once matured his long-cherished plans.

Of course he first repaired to his brother Christian, the weaver in Osterode, to devise with him the plan of his new undertaking. Christian entertained a very high opinion of his brother; he had always taken great interest in his educational schemes; and had eagerly entered into all the details of his life with Pestalozzi. Fröbel's offer to devote himself entirely to the education of his nephews, and to begin his long-prepared work with such a labour of piety, was gladly accepted, and to mark his own sense of confidence and esteem, Christian put two of his own children also under his brother's care.

November 13th, 1816, may be noted as the day when Fröbel entered upon his own independent labours at Griesheim. He now summoned to his assistance Middendorf, who at once relinquished his design of taking holy orders, and joined his beloved and respected friend, by whom he was as it were spell-bound. Fröbel was to him all in all.

The two men were very different in their natural dispositions. Fröbel was all choleric fire, quick in temper, passionate in whatever he took in hand; Middendorf was always calm, gentle, a man of womanly tenderness, all feeling, all sympathy with his fellow-men, a very Saint John in character. Fröbel had an eye pensive, reflecting, scrutinizing, and, as it were, looking inward; Middendorf's eye was bright, clear, beaming with kindness, faithfully portraying his childlike mind. Fröbel's impulsive nature often blinded him as to men and matters. Enthusiastic at once, he would entertain the most extravagant expectations in regard to men and things, such as could never be satisfied; and then, on seeing his error, would fall into the other extreme of despair when there was little need to do so. It was Middendorf's part to judge calmly and justly, and to smooth down with kind and tender hands any roughness, any unpleasantness which his friend might have caused.

Like Luther and Melancthon, these friends were the complementary opposites each of the other. They found their common bond in their love for children, for mankind, for God, and in their self-denying devotion to the divine idea which had such entire possession of them. Fröbel was the creative, the inventive genius; but the gift of clear, lucid utterance was denied him. Middendorf was his mouthpiece—an orator whose clear, warm-hearted, poetical diction nobody could resist. The melodious tones of his voice, the noble fire of his

eye, the true portraiture of his whole inner being, the inexpressible charm of thorough conviction, of honest truth, of a rapturous love for little children, and, moreover, all this hallowed by pious modesty, by almost maiden-like bashfulness and simplicity, gave to all who heard him a never-to-be-forgotten treasure of high enjoyment. Fröbel required longer time and deeper study to be fully appreciated and admired. At first sight, any observer would be conscious that he was in the presence of an extraordinary and peculiar character. There was something about him that either filled people with awe and wonder, or caused them to laugh, and to think him eccentric and irritable. Indefatigable in his perorations, grand in his high-flown language, with eyes closed, as if they were needed to read inwardly, he was apt to entangle himself in a mass of explanatory synonyms which required the strictest attention of his listeners to unravel. But all who persevered soon felt fascinated, and found their faith in him more than justified. They could not fail to be deeply struck with high admiration of the noble, self-denying philanthropy that animated the man. One felt oneself in the presence, not so much of a professional man, as of a sublime idea embodied in human form. To the young, Fröbel was indeed the revered teacher; they looked upon him with awe and reverence: but Middendorf was their own intimate friend, their associate, who knew how to throw an irresistible poetical charm, a childlike happiness about everything he touched upon. It was just such a man that Fröbel stood in need of. Nor was it an easy task to co-operate with him; it required an amount of gentle patience, of self-forgetting humility, not frequently found. His immovable conviction that he was the bearer, the servant of an infallible divine idea, made him impatient of contradiction. Of his friends he expected not only the same restless ardour which animated himself, but unconditional concurrence with and submission to everything he ordained. In 1829 he states accordingly: 'I look upon my labours and my aspirations as an unparalleled phenomenon of our time, as indispensable and salutary for all times, as offering to mankind all that it requires and longs for in every respect. I have no objection if others think otherwise. I can bear them, I can even—and I have given proof of this—live with them. Only I cannot have in common with them one and the same aim of life. But that is not my fault, it is theirs; I do not discard them, it is they who discard me.'

(To be continued.)

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Lessons in English.

BY ALEXANDER BAIN, LL.D.,

Author of "Education as a Science."

III.—The Definition of Poetry.

We have already considered some of the ways of confounding Poetry proper with other departments, as Science, Eloquence, Morality, Religion, and have endeavoured to draw the line in each case. At the risk of some repetition, we must now survey the wide field of questions growing out of the fact that Poetry is not self-dependent, but must have a subject. This is the one main reason why it so easily passes into other provinces: assuming to be, at one time, science; at another time oratory, and so on; professing to be poetry all the while. The arts peculiar to the poet—his images and fancies, his exquisite groupings and harmonies—cannot subsist entirely apart.

The most frequent of all poetic subjects is Narrative, or Story: the ongoings of our own kindred; *quidquid agunt homines.* Now, to narrate is an art by itself: it follows laws of its own, and involves skill in the narrator. We may have a plain narrative well told from the historian's point of view; we may have the same subject poetically adorned; the poet being now narrator and poet in one. It does not follow that the properly narrative part is well done, because it is converted into poetry: although the poet is easily led to suppose that he is as good in narrative proper, as he may be in poetical ornament.

But this is not the worst snare to be encountered. A narrative subject may have an independent interest of the very kind that the poetic art in its purest examples delights to afford. The feelings of sublimity and pathos are pre-eminently feelings belonging to Art, and, if they can be produced by a composition devoid of poetical adornment, they are still welcome. Now, many narratives inspire such feelings, although so bald and simple, as not to be confounded with poetry in the smallest degree. The remark was made by Sir G. Cornewall Lewis that the account of the battle of Marathon could not be perused for the hundredth time without emotion. So grand and inspiring was the barest relation of the incidents, that nothing more was needed to fill the mind with the sublime of heroism and devotion. Now, these are the very sentiments whose production would be regarded as a triumph of art. Nevertheless, the poetical treatment was superadded. In the Grecian Drama, as, for example, the *Persæ* of Æschylus, poetic genius was employed to intensify the emotions that the mere history would never fail to awaken in after ages.

If a second example is necessary, Greece can furnish it. In one of the speeches of Lysias, we have the recital of the heroic attitude of Socrates in confronting the Thirty Tyrants; and in the *Memorabilia* of Xenophon we learn how he stood out against the popular assembly, when urged, as Prytanis, to put an unconstitutional question to the vote. In both instances we have the moral sublime in a naked recital of the facts. The opening stanza of a well-known Ode of Horace (without apparently having Socrates in view) poetizes both situations with the felicitous brevity of the poet.

Justum et tenacem propositi virum
Non civium ardor prava jubentium,
Non vultus instantis tyranni
Mente quatit solida.

The man of firm and righteous will,
No rabble, clamorous for the wrong,
No tyrant's brow, whose frown may kill,
Can shake the strength that makes him strong:
Conington.

It is needless to multiply examples. Every heroic or noble action, every heroic personage, can be described in unadorned, and also in adorned, language. The emotion is intensified by the adornment, but not created. It is easy for a poet, in such circumstances, to remit his poetical handling, and to rest satisfied with the fact that the emotional effects are not remitted; the subject being operative by its unaided

influence. Compare the French Revolution as treated in prosaic style, with Carlyle's treatment. Take also the Roman traditions worked up in Macaulay's *Lays*, and compare the one form with the other.

This last consideration will help us to understand Wordsworth's vacillation as to the nature of poetry. He lighted upon matters of fact so intensely emotional, that poetic handling seemed to be dispensed with, as scarcely contributing anything to the effect. He always observed the metrical form, which is of itself of the nature of poetry; he also used the choicest of the ordinary words that the language afforded for the expression of the fact: very often he did no more. He did not deceive himself into mistaking a lifeless, for a stirring composition. There was still enough to rouse the intended emotion, and to do this was, in his judgment, to be poetical. Take as an example the odes on "Lucy." There are stanzas heightened by poetic arts; others are entirely bald and unadorned, yet not flat or devoid of effect. There is profound pathos, without a particle of poetic elevation beyond the metre, in the lines—

> She lived unknown, and few could know
> When Lucy ceased to be;
> But she is in her grave, and, oh,
> The difference to me!

The objection to such writing is, not that it does not move us, but that it appears within the reach of any one without being a poet. Quite different is the verse immediately preceding—

> A violet by a mossy stone,
> Half hidden from the eye!
> Fair as a star, when only one
> Is shining in the sky.

Comment upon this is unnecessary.

To take another short example, "Thoughts too deep for tears," is a memorable stroke of felicitous expression; "thoughts that drew forth tears" is too perfectly hacknied and easy, although in the circumstances, pathetic.

The greatest poets of antiquity were fully conscious of the difference between interest independent of their treatment, and what was their duty as artists. Virgil and Horace chose interesting subjects; yet they knew what was requisite besides in order to form poetry. In the "Georgics," Virgil never omits an ornamental phrase (Simcox's "Latin Literature," I. 263).

A poet cannot be giving birth to felicities of expression in every line; he must at times descend to the level of good ordinary diction, while his readers have to be satisfied with the interest of the thought; yet he must not throw upon his subject, whatever that may be, the whole burden of keeping up the charm.

There still remains an important observation carrying us into the very depths of art. The poetic narrator may appear to be using language not a whit more elevated than an unpoetical historian. Nevertheless, there is something in the poet's way of bringing forward the facts that we do not find in the other. Allow that Wordsworth often gives us pages without a stroke that Mr. Austin would call "transfiguration," he yet tells a story remarkably well. What interest is in it he brings out, not merely by well-chosen, although common expressions, but by his manner of selecting and arranging the incidents. This is the merit that of all others is very difficult to make apparent. The reader is satisfied with the effect without knowing how it comes. He does not, for example, know that the poet's delicate judgment has made omissions that would not have been made by a narrator devoid of the poetical sense. Before we say of a poet, as Jeffrey of Wordsworth, "This will never do," simply on the ground that he has too seldom ascended the brightest heaven of poetical invention, we must judge of the power of his story as due to selection of circumstances.

A good illustration of the point is supplied by the peculiarly poetic interest of Plot. A historian gives us this interest without thinking of it; his narrative contains it whether he will or not. An artistic narrator develops the interest by studying its conditions, and by suiting the choice and sequence of the facts to these conditions. Hence it is from a Walter Scott, or a Wilkie Collins, and not from an ordinary historian, that we obtain this mode of pleasure at its best.

Another example may be taken from the unfolding and mutual action of character in the Epic and the Drama. Several whole books of Homer are devoid of similes, which are Homer's great instruments of transfiguration. Nevertheless, these books receive the highest praise for other characteristics distinguishing the poet from the mere narrator.

The poet finds occasionally that the action can be made so animated and diversified that other interest is unnecessary (Gladstone's "Homer," p. 150). Yet in this we may trace a poet's hand—a power that a mere annalist could not put forth. Selection, omission, and disposition of parts, are as vital to poetry as verbal ornament. The critic has no easy task in disclosing the secrets of this branch of the poetic art. Only the poet himself could tell us all his trials and rejections; the critic or the teacher, when dealing with a consummate artist, needs to imagine what an inferior composer would have done; they can work to advantage only with an artist that mixes defects with his merits.

At a later stage, we shall have to consider the import of the term "Ideality," as applied to Poetry and Art, which will be an opportunity for making the foregoing remarks somewhat more telling.

To pass from narrative to another frequent theme of poetry—the Description of external nature. The geographer, topographer, naturalist, are rivals in this undertaking. And a great geographer, like Humboldt, describing the grandeurs of natural scenery, produces upon the minds of his readers the emotions most proper to art; emotions so genuinely artistic, that the artist desires nothing beyond. Yet a poet, to be a poet, must do something more. Happy in the intrinsic force of his subject, he must impart an additional charm from his own special handling. He may occasionally pause, and relieve the strain of invention, by falling to the level of a geographer who merely wields the common unadorned style. The greatness of the subject will tide him over short intervals of flatness of expression; but he must not forget himself too long. As remarked under Narrative, he may be exercising the less obtrusive devices of his art; the careful selection and omission of descriptive circumstances, rendering his composition effective without brilliant or distinguishing strokes of the transfiguring kind.

Leigh Hunt furnishes an apposite example from Natural History, in the treatment of the lily. A gardener and a botanist would each describe it in their

own terms, which would be perfectly plain and prosaical, but yet reflecting the intrinsic interest of the subject. The poet might adopt these, and be content. Poets have not stopped at this point. With Spenser, it is the 'lady' of the garden; with Ben Jonson—

The plant and flower of *light.*

Let us pass next to the adoption of Doctrinal truth as a poetic subject. This includes not simply hard science in its technical and rigid dress, but also doctrinal views of the more popular kind in all matters that interest the ordinary mind. Enough has been said on the contrast of poetry and science strictly so-called; but the illustration of the points already brought forward needs to be carried a little further.

We find in the writings of critics such remarks as these:—"Truth of every kind belongs to the poet, provided it can bud into any kind of beauty" (Leigh Hunt). A great poet, whatever his ideas may be, must work "under the conditions immutably fixed by the laws of poetic beauty and poetic truth" (Mr. Arnold). The general principle is incontestable, but the applications are not always free from difficulty.

There is first the question as to the kind of truth that readily lends itself to poetic handling. Here, as in narrative, the poet likes to have a subject that has a sustaining interest of its own, so as to carry the reader forward when the poetic aids are intermitted. This does not apply to all kinds of truth. Moreover, some truths are even repugnant to the emotions of poetry: their value lying in their useful applications, and not in their æsthetic interest. Political economy has been called a "dismal" science, because its doctrines are unpalatable in the statement, however valuable as guidance. Thomas Campbell regards the optical explanation of the rainbow as anti-poetical. On the other hand, the grandeurs of Astronomy are half way to poetry, before the poet puts his hand to them.

The poet and the scientific man cannot travel long together. Science to fulfil its vocation must be precise; this needs limitations, qualifications, and, often, numerical statements, which freeze up poetry. Plato is said to have given a poetical philosophy, but when he was most scientific he abandoned the poetic dress. It is in the less exact departments of science, as Ethics, Politics, Æsthetics, that least resistance is offered to the poetic handling. There are also practical sciences of great human interest, and for this reason are they seized hold of in poetry.

A worse incompatibility remains. The poet, when he finds a truth not to his liking, forthwith derides, evades, or perverts it. If the scientific man remonstrates, he is called a "black-browed sophist," he is "foul with sin" (Tennyson); he is denounced as capable of "botanising on a mother's grave" (Wordsworth). The fallacy of the Stoics that—"There is nothing either good or bad, but thinking makes it so," finds favour with our poets. In the zeal to make the external world more poetical, even the stars are tampered with; the fiction of sphere music is adopted and improved upon, until we reach the gorgeous Shakespearian lines—

"Not a star that thou beholdest...."

Excepting as a bad example, this does no harm.

Tennyson's attempts to disparage Geology by his poetic indignation may be seen in *In Memoriam*, 119, 123.

Leigh Hunt tells us:—"A true poet is by nature a metaphysician; far greater in general than metaphysicians professed. He feels instinctively what the others get at by long standing." To laud the power of instinct is a most agreeable flattery; it relieves us from the pains of laborious research.

The kind of science or doctrine that plays the greatest part as a subject of poetry is what bears upon human life in its manifold aspects—upon politics, morality, and the theory of right living. Political saws are very frequent matter for poetic allusion. They abound in our great poets from Shakespeare to Tennyson. The proper relations of ruler and subjects, the duties and the rights of each, frequently come up in connection with epic and dramatic themes. These have an interest in themselves, from their relation to human well-being; and a poet may trust to their aid for carrying the reader on, while his art is in abeyance.

It is easy to pronounce on what occasions they are properly admitted into poetry; whether they are shaped for poetical effect, and whether or not they are assisted by the poet's own art. There is poetry in the lines of Goldsmith—

Ill fares the land, to hastening ills a prey,
Where wealth accumulates, and men decay—
Princes and lords may flourish, or may fade—
A breath can make them, as a breath has made:
But a bold peasantry, their country's pride,
When once destroyed, can never be supplied.

This is a welcome sentiment, poetically expressed. The inferior orders of society are pleased and flattered to be told of the flimsy tenure of "princes and lords"; although very little discernment is necessary to show its want of truth. Much more than a breath is necessary to make princes and lords.

Tennyson also abounds in political commonplaces, often exquisitely touched, but without being made more scientifically true.

More usual still is it for poets to introduce Morality, or the principles of moral right and wrong, to enhance the interest and the worth of their compositions. This is perfectly admissible, on the understanding that the morality is not the poetry; although the union of the two makes a highly meritorious work; just as the union of poetry and abstract science would be, if, as can seldom happen, the two were reconcileable. A poet that can carry along with him an intensely interesting subject, and give it a full poetical treatment, is necessarily greater than one that bestows the same degree of poetic force on a neutral or indifferent subject.

The first and simplest of moral applications is to deal out justice to persons according to the received moral standard. The ordinary novelist must do this to be tolerated. It belongs to the art of pleasing the audience addressed. It was incumbent on Homer, so far as his story allowed. Scott is a master of the proprieties of poetic justice.

A poet may take a higher flight, and make his poem purposely moral: that is, he may shape his characters and incidents with the express view of setting forth the punishment of vice and the reward of virtue. This was exemplified in many of the ancient tragedies; the greatest modern instance is Dante. Such works are not simple poems: they are more or less successful combinations of moral preaching with poetry, neither of which attains perfection under such a plan. The compound is fascinating from the circumstance,

already adverted to, that a poetical morality is not intended for practice.

The poet's loftiest aim, in connection with moral good and evil, is to "vindicate the ways of God to man," to grapple with the anomalies of good men made to suffer and bad men triumphant. In adopting incidents from actual life, such difficulties are not to be glossed over by the idealising process. This was the theme of the ancient tragedy, and has drawn forth the most powerful strains of poetic inspiration and originality. Apart from such a splendid result, it would scarcely be a proper subject for poetry: it deviates too far from the condition of being agreeable. Had Shakespeare, however, never grappled with tragic themes, we should not have known the compass of his genius. Nevertheless, these subjects must be considered exceptional; they should be chosen only because of the poetic merits that they give birth to. The fascination of suffering must not be carried far; the indulgence is degrading to human nature. All literatures are full of the abuse of the license. The treatment of the problem of evil, by Milton and by Pope, is too argumentative for poetry; it is more on the level of the theological chair.

Different from all these modes of introducing moral themes, although freely intermingling with them, is the employment of poetry as Life-guidance, and "Life-criticism," a phrase invented by Mr. Matthew Arnold, and given by him, with certain limitations, as a definition of poetry. That Life-criticism is not the essence, but a valuable adjunct of poetry, and a characteristic of certain poets, for example, Wordsworth, has been abundantly shown by Mr. Austin. But, indeed, we need to study carefully the exemplary instances, in order to know what the phrase exactly means, for, like many other general words applied for the purpose of a definition of poetry, it has a variety of senses.

One meaning of the phrase is given by its author—"How to live." To teach the art of living well is a vast function, requiring immense knowledge of human nature and human life. Now, it would seem proper that whoever aspires to this great undertaking should be disenthralled from the conditions of poetic form, and should give his whole mind to making his directions just and clear. In point of fact, however, the poet has never done more than adopt the received formulas of right living, and put them in an attractive dress. He avails himself of the interest attaching to the great question of how to live, and merely superadds his own treatment to enhance what he does not create. If we were anxious for more specific and literal directions as to the conduct of life than are furnished by the old common-places; if we wanted some clear rules to go by, we should gladly dispense with the poetic dress (which is the enemy of precision) and prefer a style as bald as Euclid's, and as technical as Jeremy Bentham's. No man would steer a ship round Cape Horn and across the Pacific upon a poetical guide to navigation. But let us see a characteristic example of Wordsworth's Life-guidance:

> Of truth, of grandeur, beauty, love and hope,
> And melancholy fear subdued by faith,
> Of blessed consolations in distress,
> Of moral strength and intellectual power,
> Of joy in widest commonalty spread.

This is noble phraseology, and lifts the imagination above the vulgar routine of life. The first line is a series of qualities to aim at; but they must be viewed emotionally rather than intellectually. "Truth" in the mind of the poet is quite different from truth in science or in practice. "Grandeur" and "beauty" are the distinctive qualities of all art. "Love" is a poet's favourite subject, owing to its intrinsic charm. The idea of "Hope" always captivates us. There is a cumulative charm in the entire collocation; but there is neither direction nor instruction to be obtained from it.

The second and third lines express a high function of poetry, for which mankind will never cease to be grateful. It is the most notable of all the functions included under the vague designation "Life-criticism," or "How to live." "Melancholy fear subdued by faith, and blessed consolations in distress" express one of the perennial wants of human life. It is not exactly telling us how to live; although indirectly affording us assistance in right living.

If we lose sight of the fact that Art in general and Poetry in particular are meant to impart pleasure, as their primary end, we fall into endless confusion. There is, however, a bad association with the name "pleasure" that makes us wish to disconnect it from the noble vocation of the poet. But we have not the like objection to be relieved from melancholy and distress; nevertheless, this can be done only by the same arts that contribute to heighten our enjoyment, when we are already in some degree happy. To make the distressed more so, and to plunge the happy or the neutral into distress, would not be a good work. Far better than Life-criticism or Life-guidance would be a definition of poetry that took the two lines above quoted for the key-note. Poetry, whether or not it criticises life, should use its peculiar resources to make us less miserable or more joyous. As relief in depression, as consolation in sorrow, as an antidote to the ills of life, poetry has been welcomed since it first began. What would be the worth of grandeur or beauty, were it not to make life more endurable and more buoyant? If the poet performs any other function at the same time; if he instructs us in the laws of things; if he directs our paths when we are in difficulty, —all these are superadded functions, and must not displace the primary requisite of contributing to our enjoyment or lessening our misery.

We recognise, then, the general fact, that Poetry, as a Fine Art, is pain-allaying and pleasure-imparting. By what innumerable devices it accomplishes this high vocation, the entire compass of Rhetoric alone can tell. But with a view to the settlement of the disputed border-land of poetry and life-guidance, we need to remark that poetry has certain specific ways of operating, and takes more especially in hand a certain class of pains to be alleviated. First, however, let us complete the comment on Wordsworth's lines. The fourth—"Of moral strength and intellectual power" —is not suggestive of anything peculiar. The novel point lies in the fifth:—"Of joy in widest commonalty spread." Here we have a very notable moral idea—the finding of our pleasure in the pleasure of others. It does not directly imply self-sacrifice, but it involves a regard to the welfare of a wide-surrounding circle. If poetry is able to help in this object, it is more than pleasure-giving, or than distress-alleviating; it fosters social duty, which is what the moral teacher in all ages has been striving to accomplish. So vital is this operation, that we excuse any man, whatever his principal function may be, for stepping aside even from that

function, if he can promote the other. Yet it is by no means the express duty of the poet; and is not accounted so by poets generally. Fine Art pleasures in general have one ennobling distinction, that they can be enjoyed by mankind generally, and are not monopolised and exhausted by a few, as is the case with some pleasures. This circumstance is connected with the very material of Art, and is not due to any intention on the part of the artist.

To return now to the main function of poetry, the contributing to our joys, and the alleviating of our griefs. We need not even summarise the means of bringing about these ends; it is enough to advert to the most paradoxical of these, namely, the employment of subjects absolutely painful. Many of Wordsworth's narrative poems are tragical, not to say harrowing; while they seldom rise to the heights of tragic art, and are not redeemed by anything in the treatment. One justification might be given, on the purely moral ground. He might say that it was good for us to have our sympathies awakened towards human distress, instead of being wrapped up in our own comfort and immunity. Now a poet may, undoubtedly, undertake this work, but it is not a poetical duty, and will not be a substitute for poetical arts. A more relevant apology is this. In deep sorrow, it is better to go into the house of sorrow than into the house of rejoicing; and the salutary effect is more likely to be produced by a poetic handling of misery, than by a too literal picture. The heroism of endurance, the solution of moral difficulties, and all the circumstances that attract us to a tale of calamity, can be effectively embodied in a work of poetic genius; nevertheless, the genius is essential.

As to moralising generally, this is the professional work of the preacher alone. All of us are bound to contribute, according to our opportunities, to make mankind better. Any special claim upon the poet in this respect, is owing to the fact that he has more influence than other men; and that, in his search for themes of intrinsic charm, he often falls upon subjects having ethical bearings. If, then, it be the duty of men generally to take the benevolent, instead of the malevolent, attitude, towards each other; it is still more the duty of those in positions of influence, as poets undoubtedly are. From the unfortunate propensity of human beings to delight in malignity, a large amount of poetry is devoted to satire and vituperation. Many writers are occupied with exploring the weaknesses and vices of their fellow-men, without doing anything to reform them. Now, as a maxim, not of poetical criticism simply, but of universal duty, we are led to commend Coleridge for his professed "habit of wishing to discover the good and the beautiful in all that meets and surrounds me." If any one is competent to represent humanity and life in its severest and most literal truth, it is a man of science. Only an approximation to truth can be made by a man of language; and as the poet always mingles his feelings with his subject, we should wish him to incline to the amiable side. This may not make him more or less of a poet as such; the highest and most consummate genius may be found on the other side; but as the author of a mixed composition, where poetry is one part and doctrine another, the value of the doctrine must enter into the merits of his work. The malevolent temper of Pope and of Byron may not have detracted from their poetic force. Possibly if they had assumed a more amiable turn, their invention would not have answered so well to that stimulus. Their harsh views simply abate from their worth as teachers altogether. On the other hand, the claim may be made for Shakespeare that he holds a middle course between the extremes of sentimentality and malignity.

(*To be continued.*)

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The Discipline of the Mind.

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I.—INTRODUCTION.

THAT the foundation of the science and art of education must be laid in Psychology is one of those vital truths which obtain only tardy recognition, because an earlier perception of their importance would have been attended by no practical result. The discernment of law in Mind is an achievement of yesterday, and students of this mysterious region are even now but dimly feeling their way through a maze of bewildering complexity. It is not strange, therefore, that theorizers on the methods appropriate to youthful education should have neglected the observation of the mental phenomena, either in the consummate form of a civilised consciousness, or in the historic evolution which has made that form possible. It is only, indeed, within the last fifty years that the thoughts of scientific thinkers have been turned in this direction; and the idea is still so novel that practical teachers in this country can find few aids in literature to deepen their sense of its importance, or to familiarize them with the principle in its actual development.

A very few words will suffice to show the value of the principle itself. The mind of a human being, no less than the body, is a piece of Nature. It has its antecedents and native tendencies, propensities, and untaught yearnings. It might be pardonable in an age ill-accustomed to the strict impartiality of scientific observation, and unprovided with the treasures of comparative research, to imagine that, while the stars seemed to hold their fixed courses, and animals appeared to repeat the same monotonous round of fixed habit from generation to generation, the mind of man rose above the order of the world, was plastic to a practically indefinite extent, and that it lay in the power of an eager trainer, or a strenuous self-will to capacitate it for making unlimited intellectual conquests, or for taking rank with the few moral heroes whose deeds illuminate the pages of history. Proofs pour in thick and fast nowadays, however, to dissipate a belief at once so flattering to human self-sufficiency and so fatal to all true spiritual progress. An unreal picture of individual possibilities may, in certain periods of depression, act as a spiritual tonic, affording the strength to cast off a dangerous self-distrust; but a clear cognition of the permanent causes of our strength and weakness is both a more reliable guide and a more excellent safeguard.

The arts of education must rest, then, upon the conviction that the ground-plan of the future mind is pre-determined in the original constitution. There is a psychical *set*, as there is a physical build, which may

be favoured or thwarted, but which cannot be largely deviated from, although it may require a tutor of extraordinary prescience to foresee the career of the future man. We may, if we please, resolve this constitution into two parts—one supporting the mental fabric, expressing the result of long-continued habit, what the old metaphysician would have termed the 'essence' of man, and the modern biologist describes as the mind of the race; the other summarizing the influence of proximate progenitors. This is, of course, a factitious simplification, though if the case were really no more complex than that, the practical psychologist would have enough work on his hands to harmonize the broad and narrow streams of tendency; but when we remember that the antecedents of each individual mind are absolutely continuous and regressively indefinite in extent, we shall not wonder that the science of mind is still in so elementary a condition, or that human art, which cannot afford to wait upon the slow result of scientific analysis, should proceed swiftly to rules of conduct which later theory will utterly condemn.

The practical difficulty is, to carefully distinguish between those portions of the psychical fabric which are to all intents and purposes unalterable, and those later accretions which are relatively modifiable, and in the latter to faithfully graduate the relativity. It would be alike unreasonable to attempt to change a primal instinct, or to treat a certain vice as beyond the reach of moral therapeutics, because it exhibits an ancestral taint. Some sagacity, again, will be needed to distinguish—in the awkward efforts of unexercised intellect—between the irremediable inaptitude of an unpossessed faculty, and the cerebral immaturity which merely retards what will hereafter be a splendid development. These are some samples of the puzzles which await the instructor. It would be folly to ignore or underrate them. They must be admitted in all their force. But the moral to be drawn from their existence is not that of despair or evasion, but a profounder conviction that real aid must come from a deeper study of the human mind, above all in its comparative aspect. The derivative cannot advance faster than the parent science, and the laws of mind are only slowly emerging out of physical and metaphysical chaos. As my concern in these papers will be directly with the practical teacher, I shall not allow myself to wander from the beaten path of ascertained truths, but limit myself to an indication of those mental conditions which help to form the phenomena of our familiar consciousness, accompanied by such applications as are implied in a conscious direction of the mental processes, with a view to realizing the ideal end of full development of faculty.

Before we proceed to particulars, however, we must first form a correct idea of the kind of object it is whose constitution and mode of operation we are proposing to treat. This object is the human mind. The unfolding and discipline of the human mind is the purport of education. But what *is* the human mind? Does the popular phraseology correctly or adequately describe it? We hear talk of the 'faculties of the mind,' as if it were a *thing* parcelled out into provinces, an engine with unlike parts, which may be variously active or quiescent. Again, there is no more popular presumption than that mind is not body, that it is a self-enclosed sphere, open only to the gaze of an individual self, whose kinship with other individual entities is problematical, or matter of inference. The body is sometimes said to be the mind's 'slave,' at other times its 'master.'

Now, all these varieties of expression are inexact, even when not positively misleading. They are the outcome of rough-and-ready wit, and if taken up without explanation into the scientific vocabulary will seriously vitiate our conception of the actual phenomena.

The dualism thus supposed of body and mind, if taken in the popular sense, is entirely untenable. The perception that mind is *embodied mind* is the mastery of the psychological alphabet. Scientific psychology may be almost said to date from the recognition of that truth. The assertion involves something very different from the current phrase that body, in whole or part, is Organ of mind. Organ supposes substantial separation. The organ is quite distinct from the authority that wields it. It is a passive instrument of a purpose not its own. But in saying that 'mind is embodied mind' we affirm far more than that; we declare that it and its embodiment are one, that the relation is not that of hand and glove, but of hand and flesh and blood; that he who strikes at the body strikes at the mind, that he who wounds the mind wounds the body. This is no mere hypothesis or possible interpretation of facts. It is demonstrated in every ripple of feeling, in every case of mental pathology.

What becomes, then, of the so-called faculties of the mind if this be so? Where are these faculties, and how shall we effect their distinction? If the mind pulsates in the whole body, although with different energy and evidence according to local conditions, and the dominating centres are impotent without their internuncial connections, qualitative difference being grounded on difference of relation, not of elements, how can we, except by a figure of speech, talk of a faculty of judgment, of reasoning, of remembering? As we shall see presently, this phraseology is the record of a primitive attempt at classification, misdirected by a not unnatural illusion of metaphysics.

But there is something more, of scarcely less importance, to be said in regard to the special nature of mind. Theories of mind surviving in popular speech commit a similar error with regard to distinction of mind from mind, to that which they commit in regard to distinction of mind from body. It is supposed that the mind is or may be isolated from its environment, as it may be detached from its objective aspect. Now, although it must be granted that the reflex action known as self-consciousness is a peculiar phenomenon, usually described in the somewhat inappropriate language of a consciousness immediately visible to introspection, this by no means carries with it the implication that a man's mental self is in fact detachable from other mental selves, or that, in truth, there would be any self at all if it were not for a *social self*, the resources of the individual self ever growing with the growth of the social self. Self-education is a dream; there is no such possibility. A mind cannot feed upon itself—must, at the least,

> 'Find tongues in trees, books in the running brooks,
> Sermons in stones,'

and recognize its grandest teachers in the throbbing heart and progressive reason of mankind. To neglect or make light of these ultra-personal

influences is to obscure our view of the most important reality as yet known to us—the human mind. The mind of each one of us at the present day is so remote from the early mind that we cannot possibly put ourselves back in imagination and realise its ruder type. When we reflect what vast controversies, fraught with most important consequences, have hinged on the adoption of a mere *word*, we may vainly picture the cavern-like stagnation of a consciousness capable of being influenced by its fellow only through the crude media of gestures and interjections.

Language is undoubtedly the great fabricator of the social consciousness. But my point is that the individual cannot be detached from the social consciousness, that what I am thinking now is not *my* thought, but the thought of a spiritual organism of which my thought is but a transient expression. If it were not so, how could we so readily communicate our ideas to one another? If we did not share in a common psychical nature, how should we be so readily intelligible to one another? It is not the possession of a common language which alone makes this possible. Language is the body of thought and feeling, a body as intimately one with its spirit as the physical body of the psychical mind, but the informing soul must be present or the body is a dead burden.

How vast the range of personal influence becomes in the social state when this is fully realized, it is needless to enlarge upon. It is this great fact which gives such overwhelming importance to the work of the educator, and enables the schoolmaster who is alive to his responsibilities to shape in great measure the destiny of mankind.

I think these preliminary observations regarding the general nature of mind will suffice for placing the student at what appears to me to be the proper point of view for comprehending psychological problems. They are intended to suggest to the reader certain general conceptions which have not yet received the attention they deserve. At the same time, I fear the value of the truths indicated will for some time to come be rather *regulative* than *constitutive*. By this I mean that they must be treated by the teacher mainly as pre-suppositions, possessing a restraining value, preserving from dangerous error, rather than as presenting positive material which can largely influence practice. For the body of psychological doctrine on which to found practical rules we must still go to the abstract analyst, to the descriptive psychologist, who, treating the mind as a separate finished organism, places in our hands the skeins of association, as they present themselves to his individual inspection. But, although this mode of treatment must still be classed as primary, the historical spirit is beginning to make itself felt in psychology, as in all other departments of life, and the hitherto neglected antecedents of the infant mind are coming to receive their due. Even now Psychogeny is found a potent instrument where simple observation and analysis fail, and we are obtaining glimpses of light where before was darkness and mystery.

Employing such clues as the progress of science offers I shall, in the rest of the present paper, attempt a rapid survey of the field of mental phenomena, presenting these phenomena so far as possible as a connected whole.

In one sense everything which forms a portion of our thought is a mental phenomenon. Although we are tolerably sure that the world is larger than Human Mind, the very conditions of our life prevent us from conceiving that world save in terms of more or less distinct ideation and conscious action. That there are subconscious and unconscious states few will deny, but the *notion* of such states is a fact of consciousness, and it is a fallacy of language when we imagine ourselves capable of transcending this limitation of human spiritual existence. But because we are fast bound within the iron bands of consciousness, it does not follow that the limits of representation should be the limits of belief, and accordingly, while the stream of our mental being yields us only the gold of consciousness, that very gold may bear upon it the mark of its transmutation from the common sand of the unconscious. It is, in truth, so. As Shakespeare said:—

'Our little life is rounded with a sleep;'

and consciousness is but a gleam of light in a vast ocean of gloom.

The area of unconsciousness is immeasurably vaster than the area of consciousness, not only without the life of humanity, but also within it. We shall never understand the workings of consciousness itself until we come fully to admit that a vast number of operations are ceaselessly going their silent rounds, of which either no trace exists in consciousness, or of which the effect is perceived without the cause.

The proof of this is found in flashes of so-called inspiration or memory, in incredibly swift perceptions or intuitions, in sudden decisions which pre-suppose long chains of inference and inward struggle. Some psychologists endeavour to resist this evidence. They will have it that as the effect, so must be the cause, that to make the conscious emerge from the unconscious were to violate the maxim *Ex nihilo nihil fit;* and that to find an unconscious antecedent for a conscious consequent is to confuse two eternally opposed spheres of being. But there is nothing self-contradictory in the assertion that existence is larger than mind, and yet the unconscious consubstantial with consciousness. On the contrary the contradiction lies with those who declare we are strictly bound within the fetters of consciousness, and at the same time postulate an unknown substratum as the condition of that consciousness. To argue this point further would lead me too far. We must rest in this place with the verdict of common sense; and the interpretation of experience, which most readily yields practical fruit, is that which conceives the mind as ruminating in stillness over its assimilated material, and from time to time revealing the strange treasures of its wonderful laboratory.

(*To be continued.*)

A CHEAP VOLTAIC CELL.—A cell suitable for ringing electric bells in houses can be procured in the following cheap but efficacious manner. Get a porous clay pot from an electrical instrument maker (price twopence); put it in an old iron 'tin' and fill up the can with a solution of caustic soda. Then roll up a piece of zinc and stick it in a plug of cork or wood soaked in melted paraffin wax; fill the pot with water and insert the zinc. Solder wires to the zinc and the iron tin, and the cell is complete. The efficacy of the cell may be increased by filling the space between the iron tin and porous pot with iron filings.

Chemistry of the Non-Metallics.

BY EDWARD B. AVELING, D.SC. LONDON.

[This series of articles, whilst dealing with the subjects required by the University of London for the Matriculation Examination and with those required at the Elementary Stage of the Inorganic Chemistry (Branch X.) Science and Art Department, is intended as a practical guide to the philosophical and systematic study of the non-metallics.]

CHAPTER I.—ELEMENTS. MIXTURES. COMPOUNDS. CHEMISTRY. METALS. NON-METALS. SYMBOLS. WEIGHT-NUMBERS. LIST OF ELEMENTS.

LET us suppose that the following substances, all easily procurable, are placed upon the table before the student:—Brimstone, chalk, charcoal, a piece of glass, a bottle of glycerine, gold-leaf, gunpowder, iron filings, iron and powdered sulphur rubbed together in a mortar, a penny, some phosphorus, a shilling, a sovereign, some spermaceti, some starch, a lump of sugar, some sugar dissolved in water, sugar mixed with potassium chlorate (chlorate of potash of the chemist's shop), a glass of water, a piece of zinc.

If the student were asked to attempt some grouping of these twenty things, we may believe that, either unaided, save by his own native wit, or with a little guidance from his teacher, he would after a time place apart from all the rest, the glycerine, the spermaceti, the starch, and the sugar. These all come from plants or animals; these are *organic bodies*. The rest, noting that the organic body sugar occurred in two out of the seventeen things left, he would name *inorganic bodies*.

Considering these sixteen, he would in time place on one side the brimstone, charcoal, gold-leaf, iron, phosphorus, zinc, and he would, if not guided, place with these the three coins, unless he remembered that the penny, shilling, and sovereign are made up of copper, silver, and gold, in each case accompanied by some other substances. This group of six, noting that one of the six occurred in conjunction with iron in another substance on the table, he will separate from the rest, because they are all bodies that have not, as yet, been decomposed or analysed into simpler substances. Brimstone or sulphur, charcoal or carbon, gold, iron, phosphorus, zinc, are *elements* or *simple bodies*.

Turning to the ten things still before him, the student would arrange them in two groups. In one he would place the gunpowder, the iron and sulphur, the solution of sugar, the sugar and potassium chlorate; in the other he would place the chalk, the piece of glass, the water. The one group he would name *mixtures*, the other *chemical compounds*. The gunpowder he would recognise as a mixture of nitre, sulphur, charcoal; the chalk as a chemical compound of calcium, carbon, and oxygen. The penny, shilling and sovereign would present some difficulty. They are alloys of two or three elements. Upon the whole, it is better to place them with the compounds, though they hover close to the border-lines of the two groups of elements and compounds.

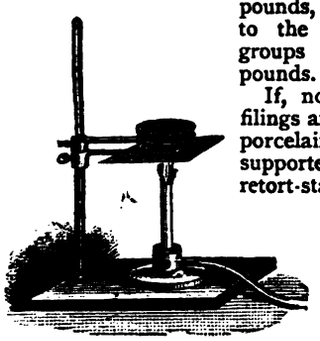

FIG. 1.

If, now, the mixture of iron filings and sulphur be placed in a porcelain capsule, and the capsule supported on one of the rings of a retort-stand (Fig. 1), whilst upon a lower ring some wire-gauze is placed, at such a level as to be only just below the bottom of the capsule, and if the flame of a Bunsen burner be applied to the bottom of the capsule through the wire-gauze, the iron and sulphur are found to unite, and a black substance is formed unlike either sulphur or iron. This substance is a compound of the two elements.

If a glass rod is dipped in very strong sulphuric acid and then applied to the mixture of sugar and potassium chlorate, flame bursts out, and a yellow gas is given off. From the mixture certain quite different compounds result, compounds that have not the same properties as the sugar, the chlorate, and the acid, out of which they are made. The *mechanical mixture* (*e.g.*, gunpowder), is made up of two or more elements or compounds, still retaining their individual properties. The chemical *compound* (*e.g.*, chalk), is made up of two or more elements, intimately combined, and its properties differ from the properties of its constituents.

We can now arrange our twenty substances in three columns.

(1) *Elements, not yet decomposed.*	(2) *Mixtures, of two or more bodies, whose properties are unchanged.*	(3) *Compounds, of two or more elements, with change of properties.*
a. Sulphur.	*a.* Gunpowder.	*a.* Chalk.
b. Carbon.	*b.* Iron and Sulphur.	*b.* Glass.
c. Gold.	*c.* Sugar and Water.	*c.* *Glycerine.
d. Iron.	*d.* Sugar and Potassium Chlorate.	*d.* The penny.
e. Phosphorus.		*e.* The shilling.
f. Zinc.		*f.* The sovereign.
		g. *Spermaceti.
		h. *Starch.
		i. *Sugar.
		k. Water.

The compounds marked * are organic.

As far as we know, all bodies in the universe can be arranged under one of these three heads. The study of elements, mixtures, and compounds is *Chemistry*.

Consider the six elements in the first list. They can be grouped into two sets, each of three. The gold, iron, zinc, as *metals*, are separated from the sulphur, carbon, phosphorus, as *non-metals*. The marks of the metallic elements are:—

(1) Solidity. As a rule they are solid bodies, whilst several of the non-metals are gases. Mercury is a liquid metal, and, later on, we shall see reason to believe that the gas, hydrogen, usually classed with non-metals, is metallic in its nature.
(2) Lustre.
(3) Heaviness. As a rule, metals have a greater relative weight than non-metals.
(4) Good conducting powers as regards heat and electricity.
(5) Ductility, from *duco* = I draw (the capability of being drawn out into a wire).
(6) Malleability, from *malleus* = a hammer (the capability of being hammered out into a plate).

These last two properties, whilst they are only possessed by some metals, are not possessed by any non-metals.

We know, at present, some sixty-three elements. Of these the majority are metals. Only fifteen elements at most are regarded as non-metallic, and three of these hover on the border-line between the two classes of simple bodies. In these articles we shall confine our attention to the study of the non-metallics, and to the study of twelve of these. Their names follow in the order in which they will be studied. Opposite each name is written the sign, *symbol*, or abbreviation that is used by students of chemistry for the purpose of saving time. Most of these elements recur so frequently in the study of this science that it is wise and necessary to have some symbol by which to designate them. Lastly, each element has, in addition to its symbol, a number. This I call its *weight-number*. Without entering too fully at present into the meaning of these numbers, it may here be said that they express the relative weights of the different elements under like conditions. Thus hydrogen (1 in the list) is the lightest body known, and oxygen (16 in the list) is, under like conditions, sixteen times as heavy as hydrogen. The phrase 'under like conditions' is of great importance. Thus the solid, carbon, is far more than twelve times as heavy as the gas, hydrogen. But we have evidence that if hydrogen and carbon could be compared in the gas condition, at the same temperature, under the same pressure, the latter would be found to be twelve times as heavy as the former.

So-called Non-Metallic Elements.

Name.	*Symbol.*	*Weight-number.*
Hydrogen	H.	1
Oxygen	O.	16
Nitrogen	N.	14
Carbon	C.	12
Chlorine	Cl.	35·5
Bromine	Br.	80
Icdine	I.	127
Fluorine	F.	19
Sulphur	S.	32
Phosphorus	P.	31
Silicon	Si.	28
Boron	B.	11

So-called Metallic Elements.

[A complete list is given for the purpose of reference, but the student will not have to deal with more than some fifteen of the common metals.]

Name.	*Symbol.*	*Weight-number.*
Aluminium	Al.	27·3
Antimony (Stibium) ...	Sb.	122·3
*Arsenic	As.	75·2
Barium	Ba.	137·2
Bismuth	Bi.	210·0
Cadmium	Cd.	112 0
Cœsium	Cs.	133·0
Calcium	Ca.	40·0
Cerium	Ce.	92·2
Chromium	Cr.	52·1
Cobalt	Co.	58·7
Copper (Cuprum) ...	Cu.	63·1
Didymium	D.	95 0
Erbium	E.	112·6
Glucinum	Gl.	9·3
Gold (Aurum)	Au.	196·7
Indium	In.	113·4
Iridium	Ir.	196·9
Iron (Ferrum)	Fe.	56·0
Lanthamum	La.	92·9
Lead (Plumbum) ...	Pb.	206·9
Lithium	Li.	7·0
Magnesium	Mg.	24·0
Manganese	Mn.	55·0
Mercury (Hydrargyrum)	Hg.	200·0
Molybdenum	Mo.	96·0
Nickel	Ni.	58·7
Niobium	Nb.	94 0
Osmium	Os.	199 1
Palladium	Pd.	106·6
Platinum	Pt.	197·2
Potassium (Kalium) ...	K.	39·1
Rhodium	Rh.	104·2
Rubidium	Rb.	85·4
Ruthenium	Ru.	104·4
*Selenium	Se.	79·5
Silver (Argentum) ...	Ag.	107·9
Sodium (Natrium) ...	Na.	23·0
Strontium	Sr.	87·5
Tantalum	Ta.	182·3
*Tellurium	Te.	128·0
Thallium	Tl.	203·5
Thorium	Th.	115·7
Tin (Stannum) ...	Sn.	118·1
Titanium	Ti.	50·0
Tungsten (Wolfram) ...	W.	184 0
Uranium	U.	237 6
Vanadium	V.	51·3
Yttrium	Y.	61 7
Zinc	Zn.	65·2
Zirconium	Zr.	89 6

The three elements whose names are marked * are those that are sometimes classed with the non-metals. This fact, and the phrase, 'So-called non-metallic elements,' remind us that our classification, though useful, is artificial.

CHAPTER II.—PLAN OF WORK.

As we enter upon that study of elements, mixtures, and compounds which we call Chemistry, it is necessary to make clear the method of study. Each of the elements enumerated on the opposite page, will be considered under the following heads :—

A. SYMBOL.
B. WEIGHT-NUMBER.
C. PREPARATION.

First, to paraphrase an apocryphal utterance, 'catch your element.' The method or methods of preparing the simple body under consideration will be studied along these lines.

(1) *Laboratory method.*—A description of the experiment necessary, with the substances and apparatus used, and the names of the products formed.

(2) *Symbols of the reaction.*—The shorthand notes of the experiment just described are given in the chemical symbols of the bodies used and the substances formed.

(3) *Weights and volumes.*—The relative weights of the materials concerned in the preparation and their volumes (when they are gases) are calculated. The table of weight-numbers on the opposite page is of use here.

D. PROPERTIES.—These are studied in the order in which they would seem to strike the observer; the most general are taken first, the most special later.

(1) *Condition.*—Whether the body is a solid, a liquid, or a gas. If it is a solid or a liquid, the temperature at which it melts or boils should be given. If it is a gas, the ease or difficulty with which it is liquefied should be noted.

(2) *Effect on the senses.*—Those of touch, taste, smell, sight.

(3) *Specific gravity.*—The relative weight, as compared with distilled water at a temperature of 4° and under a pressure equivalent to the weight of a column of mercury 760 millimetres (about thirty inches) in height, if the body is a solid or a liquid; as compared with hydrogen or air, if the body is a gas. The number that represents the specific gravity of a body also represents its *density*. But specific gravity and density are no more the same thing than the number of pence in a shilling and the number of months in a year. Specific gravity is relative weight. Density is relative mass. Weight is the force with which a body tends to move towards the earth. Mass is amount of matter. If everything in the universe could be annihilated except one pound of lead, that lead would no longer have any weight, but its mass would be the same as before.

(4) *Solubility.*—In water or in acids.

(5) *Relation to combustion.*—Whether the element is combustible or not, is a supporter of combustion or not.

(6) *Specialties.*—Under this head are recorded such properties as are not considered under any of the preceding heads; as, *e.g.*, the reaction upon litmus paper or any special tests for the particular element.

E. MIXTURES AND COMPOUNDS INTO WHICH IT ENTERS.

The mixtures and compounds will be studied upon the same plan as the element. That is, the symbol, weight-number, preparation, properties of each mixture, and of each compound will be studied wherever they admit of study.

I sum up this plan, and earnestly advise each student to use it, or some similar—and possibly better—scheme. Every fact in regard to every element, mixture, or compound, should be thought of under its proper head in this plan. Its relationship to other facts will thus be rendered clear, and the remembrance of it will be made more easy.

PLAN.

A. SYMBOL.
B. WEIGHT-NUMBER.
C. PREPARATION.—(1) Laboratory method.
(2) Symbols of reaction.
(3) Weights and volumes.
D. PROPERTIES.— (1) Condition.
(2) Effect on senses.
(3) Specific gravity.
(4) Solubility.
(5) Relation to combustion.
(6) Specialties.
E. MIXTURES AND COMPOUNDS.—Each studied under heads *A, B, C, D.*

(To be continued.)

ANSWERS TO ARITHMETICAL QUESTIONS IN THE 'SCHOLAR' FOR MARCH, 1884.

STANDARD IV.

A. 1. £85 1s. 10½d.
2. £92 8s. 5½d.
3. 31,622,400 sec.
B. 1. 13 lb. 4 oz. 1 dwt. 5 gr.
2. £28 7s. 11½d. – 83.
3. 2,718,220 oz.
C. 1. £7094 7s. 3½d.
2. 3s. 9d.
3. 15 c. yd. 8 ft. 1171 in.
D. 1. 15 ton 9 cwt. 1 qr. 14 lb.
2. 49,957,330,802,500.
3. £46,136 5s.
E. 1. 18s. 10½d. – 14,070.
2. 158 r. 10 q. 3 sh.
3. 1,176,120 sq. in.
F. 1. 8⅔ yds.
2. 214 ton 6 cwt. 2 qr. 20 lb. 15 oz.
3. 18,000 marbles.

Advanced Examination.

1. £1657 6s. 8d.
2. 1223 ton 16 cwt. 1 qr. 4 lb. 8 oz.
3. Girl 4s. 4d., boy 3s. 6d.

STANDARD V.

A. 1. £3412 10s.
2. 10s. 6d.
3. £3 15s. 10$\frac{11}{12}$d.
B. 1. 3$\frac{3}{8}$.
2. £3085 2s. 9$\frac{3}{4}$d.
3. £4 11s. 8$\frac{13}{24}$d.
C. 1. £6 9s. 11$\frac{5}{8}$d.
2. £187 10s.
3. $\frac{1}{3}\frac{3}{3}$.
D. 1. £7 12s. 3d. loss.
2. £5529 14s. 11d.
3. 46 gallons.
E. 1. £1,493,350 8s. 2d.
2. £44 5s. 8d.
3. £123 7s. 1$\frac{1}{2}$d.
F. 1. 316,120 minutes.
2. 7 mls. 913 yds. 2 ft. 5 in. – 511.
3. 176 ft.

Advanced Examination.

1. £56 18s. 10d.
2. £145 17s. 1$\frac{2}{11}\frac{3}{11}$d.
3. £5 9s. 4d.

STANDARD VI.

A. 1. £18 0s. 5$\frac{3}{4}$d.
2. $\frac{1}{3}\frac{1}{3}$.
3. ·004.
B. 1. £91 14s. 10$\frac{3}{10}\frac{3}{0}$d.
2. £19 17s. 1$\frac{1}{2}$d.
3. £91 16s.
C. 1. 126 rats.
2. 3$\frac{2}{7}$.
3. ·00078125.
D. 1. ·0010845.
2. £6 15s. 5$\frac{5}{7}\frac{1}{1}$d.
3. $\frac{1}{8}$ of the estate.
E. 1. ·02857+
2. 44$\frac{1}{8}$ hours.
3. 7·0 yards.
F. 1. £5 0s. 1$\frac{3}{8}\frac{9}{0}$d.
2. 4$\frac{1}{8}$ per cent.
3. 110$\frac{3}{8}$ days.

Advanced Examination.

1. £2250, £2000, £1500, and £1200.
2. £91 5s.
3. £219 13s. 7$\frac{1}{2}$d.

STANDARD VII.

A. 1. 14s. 10$\frac{1}{2}$d.
2. £9 6s. 8d.
3. 2$\frac{3}{1}$ years.
B. 1. £346 17s. 6d.
2. £55 16s. 9$\frac{3}{4}$d.
3. £83 12s. 1$\frac{3}{8}\frac{3}{3}$d.
C. 1. £147$\frac{1}{4}\frac{1}{4}$.
2. £835 13s. 4d.
3. 46$\frac{2}{3}$ per cent.
D. 1. $\frac{1}{1}\frac{1}{0}$ per cent.
2. £4 7s. 10$\frac{1}{4}\frac{7}{4}\frac{1}{4}$d.
3. 37$\frac{3}{1}\frac{3}{1}$.
E. 1. $1\frac{3}{1}\frac{3}{0}$ mistakes.
2. $1\frac{3}{8}\frac{3}{3}$ per cent.
3. 5625.
F. 1. ·485 per cent.
2. 2$\frac{3}{4}$ p. c. gain.
3. £59.333 8s.

Advanced Examination.

1. £307 12s. 0·1807212d.
2. £41 a year gain.
3. 16$\frac{1}{2}$ inches.

SOLUTIONS OF THE 'ADVANCED EXAMINATION' QUESTIONS IN 'THE SCHOLAR' FOR MARCH, 1884.

STANDARD IV.

1. 4s. 8d. × 4½ = 19s. 10d. cost of cloth, + 17s. 10d. = £1 17s. 8d. total cost of each suit; and £1 17s. 8d. × 880 = £1657 6s. 8d. Ans.

2. 1223 ton 16 cwt. 1 qr. 4 lb. 8 oz. Ans. (Only a test of mechanical accuracy.)

3. 10d. × 90 = £3 15s. excess that the 90 girls receive in addition to an equal division with the boys. £34 4s. − £3 15s. = £30 9s., which, divided by (90 g. + 84 b.=) 174 = 3s. 6d. a boy's share, + 10d. = 4s. 4d. a girl's share. Ans.

STANDARD V.

1. The four items are 10s. 6d. + £16 10s. + £22 10s. + £17 8s. 4d. = £56 18s. 10d. Ans.

2. 38 ton 17 cwt. = 777 cwt., which, at 3s. 9d. a cwt. = £145 13s. 9d.

	£	s.	d.						
2 qr. is ½		3	9						
			777						
	145	13	9	price of 38 ton 17 cwt.					
1 ,, ,, ¼	0	1	10¼	,, ,,			2 qr.		
14 lb. ,, ¹/₁₆	0	0	11¹/₁₆	,, ,,			1 ,,		
2 ,, ,, ¹/₈	0	0	5⅛	,, ,,				14 lbs.	
1 ,, ,, ¹/₁₆	0	0	0¹⁵/₁₆	,, ,,				2 ,,	
8 oz. ,, ½	0	0	0¹⁵/₁₆	,, ,,				1 ,,	
4 ,, ,, ¼	0	0	0⁷¹/₁₂₈	,, ,,					8 oz.
	0	0	0³⁵/₄₄₈	,, ,,					4 ,,
					ton	cwt.	qr.	lb.	oz.
	£145	17	1³³³/₄₄₈	,, ,,	38	17	3	17	12

3. £12 3s. 4d. ÷ 365 = 8d. a day. From May 17th to Oct. 28th, the latter exclusive, is 164 days, which at 8d. a day = £5 9s. 4d. Ans.

STANDARD VI.

1. ⅜ + ½ + ¼ + ⅛ = $\frac{45+40+30+24}{120}$ = 1¹³⁹/₁₂₀ which exceeds a unit or integer—*one*. Hence, as these *fractions* cannot really be received by each, their several *ratios* must be received instead. Consequently, the whole must be divided into 139 parts instead of 120, the first receiving ⁴⁵/₁₃₉, second ⁴⁰/₁₃₉, etc. Now ¹/₁₃₉ of £6950 = £50, then £50 × 45 = £2250; £50 × 40 = £2000; £50 × 30 = £1500; and £50 × 24 = £1200. Answers.

2. Bringing the women and boys in the consequent to their equivalents in men, we have 15 boys = 6 men, since 20 boys = 8 men; and as 8 men = 12 women, a woman = ⅔ of a man, and ⅔ of 20 = 13⅓ men. Then 5 men (given) + 13⅓ men + 6 men = 24⅓ men. Then by proportion and cancelling—

$$£\frac{20 \times 24\frac{1}{3} \text{ men} \times 24}{8 \times 16} = £91\ 5s. \text{ Ans.}$$

3. 5·15 pecks × 32·5 × 20 = 3347·5 pecks = 104·609375 quarters, the produce of the 20 acres. And £2·1 × 104·609375 = £219 13s. 7½. Ans.

STANDARD VII.

1. Four per cent. for a year = ¹/₂₅, therefore for a quarter it = ¹/₁₀₀. There being 6 quarters in the 1½ years, ¹/₁₀₀ must be added successively 6 times.

¹/₁₀₀	5000	
	50	
¹/₁₀₀	5050	amount at the end of the 1st quarter
	50·5	
¹/₁₀₀	5100·5	,, ,, ,, ,, 2nd ,,
	51·005	
¹/₁₀₀	5151·505	,, ,, ,, ,, 3rd ,,
	51·51505	
¹/₁₀₀	5203·02005	,, ,, ,, ,, 4th ,,
	52·0302005	
¹/₁₀₀	5255·0502505	,, ,, ,, ,, 5th ,,
	52·550502505	
	5307·600753005	,, ,, ,, ,, 6th ,,
	5000·	
	307·600753005	= £307 12s. 0·18072 12d. Ans.

2. £41,000 at 4 per cent. = £1640 yearly income. £102·5 (¼ being deducted for brokerage) × 410 = £42,025 amount received on selling out the 4 per cent. stock. £124¼ + ¼ = £125 cost of £100 stock in the 5 per cents.; and £42,025 ÷ 125 = 336 cents. of 5 per cent. stock bought. Then £5 × 336⅕ = £1681 yearly income from the 5 per cents.; and £1681 − £1640 = £41 gain. Ans.

3. 10½ inches × 16 = 168 inches the aggregate of the 16 tides.
11½ ,, × 20 = 225 ,, ,, 20 ,,
Then 225 − 168 = 57 ,, ,, last 4 ,,
From the data the 18th tide was 1½ inches above the 17th; the 19th *three* inches above the 17th; and the 20th *four and a-half* above the 17th tide Taking these excesses (1½ + 3 + 4½ = 9) from the 57 we have 48, which ÷ 4 = 12 inches the 17th tide, and 12 in. + 4½ in. = 16½ inches. Ans.

Science Notes.

SIR CHARLES WILLIAM SIEMENS.—On the 19th of November an eminent scientist, well known in England as in other countries, passed away. Charles William Siemens, born April 4, 1823, at Leuthe in Hanover, was educated at Lubeck, Magdeburg, and Göttingen University. He was only twenty years old when he came to England with his brother Werner to realise an invention for electro-gilding, and so successful were they that William made England his home. His chief services to science may be noted in chronological order as follows: a double-cylinder air-pump, and a simple water-meter; a four horse-power steam engine with regenerative condensers, which gained him the gold medal of the Society of Arts in 1850; a modification of Grove's secondary battery; two steam engines with regenerative condensers for the Paris Exhibition of 1855; submarine cables; a pyrometer based on the principle of using the increased resistance of metallic conductors due to the rise of temperature as a means of measuring temperature; the regenerative gas furnace, his most famous invention, with which his brother Frederick was also associated; and as a consequence of the latter invention the production of steel on the open hearth, an industry now employing thousands of men; a barometer for measuring depth of the sea, and so on. Besides these his contributions to scientific literature are equally numerous and valuable; he was a member of nearly all the scientific societies of Great Britain: a D.C.L. of Oxford University in 1870, an LL.D. of Glasgow in 1880, of Dublin in 1882, in which year he also received the degree of Ph.D from Würtzburg. He was knighted by Her Majesty in March last, and had received recognition of his services from the Emperor of Brazil, the Shah of Persia, and from France under the Empire and under the Republic.

* * * * *

ASBESTOS.—There seems no limit of the uses to which asbestos can be applied; asbestos filters have recently been introduced into chemical laboratories, where their power of resistance to the action of strong acids, as well as of heat, render them especially valuable. Gloves of asbestos are also useful as protecting the skin from acids, and asbestos paper for protecting tables, etc., from acid stains. It makes good porous cells for batteries, but perhaps its most ingenious use is as an air filter. M. de Luynes has drawn the attention of the Société d'Encouragement of Paris to M. Eppé's invention in this connection, by which the air is blown by means of a fan through a bed or layer of asbestos six inches thick; the air is thus deprived of dust particles, and also is purified from germs of disease or fermentation.

THE LATE MR. HUGH POWELL.—We regret to see the notice of the death of Mr. Hugh Powell, the eminent optician. It was almost fifty years ago when, in 1834, he gained a silver medal at the Society of Arts 'for a stage for a microscope.' In 1840 he made the first achromatic object glass of one-sixteenth of an inch focal length ever seen in this country. In 1841 the Society of Arts again awarded him a silver medal 'for his mode of mounting the body of a microscope.' He was also the first English optician to construct object glasses on Amici's 'immersion' system. Still later he succeeded in constructing an object glass of a focal length of one-eighteenth of an inch. He was one of the earliest fellows of the Royal Microscopical Society, founded at London in 1840. His son is, we believe, continuing his father's experiments on the more recently developed 'homogeneous immersion' system.

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Music.

BY RALPH DUNSTAN, MUS. BAC., CANTAB.;
L. MUS., T.C.L.;
Member of the Council of the Tonic Sol-fa College, etc.

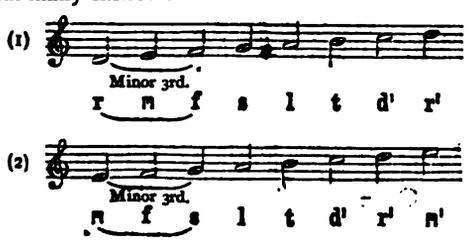
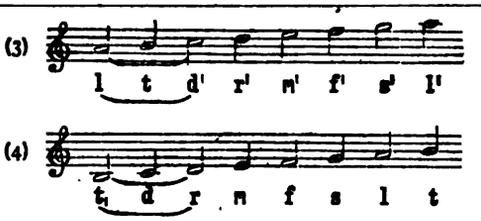
(Continued from Vol. III., page 591.)

TERMS OF STYLE :—

Ad libitum, *Ad lib.*, at the discretion of the performer (as *Rall. ad lib.*).
Agitato, with agitation.
Animato, with animation.
A poco a poco, little by little, by degrees (used to qualify some term of Expression or Speed).
Assai, very, enough (as *Allegro assai*).
Ben, well.
Brillante, in a brilliant, showy style.
Con brio, with energy.
Con espressione, with feeling or expression.
Con fuoco, with fire.
Con moto, with spirit (or motion).
Con tenerezza, with tenderness.
Grazioso, gracefully.
Legato, smoothly, in a gliding manner.
Ma, but.
Maestoso, in a grand, broad, majestic style.
Marcato, marked and emphatic (*Ben marcato*, well emphasized).
Mezzo, half (*Mezzo forte*, half or moderately loud).
Molto, much, very (*Andante molto*).
Non, not. *Più*, more. *Poco*, little. *Quasi*, almost, in the style of.
Segue, it follows. *Sempre*, always (as *Sempre ff.*)
Sostenuto, with the notes sustained their full length.
Staccato, with the notes cut short.
Tenuto, *ten.*, sustained.
Vivace, in a quick, sprightly manner.
Volti, Turn over (as *Volti subito*, Turn over quickly).

THE MINOR SCALE IN ITS VARIOUS FORMS.

Major Scales are so called because the interval from the Tonic or Key-note to the third note of the scale is a *Major* Third; when, however, the third of a scale is *Minor*, it is called a *Minor Scale.*

The student will readily perceive that there are a great many minor scales of various kinds :—

These minor scales are all formed from the notes of the scale of C major, and we may form the same number from the notes of any other major scale. All these minor scales were used before the introduction of Harmony; but in Modern Music, No. 3 only is employed, and is so much modified in its use that it appears under several distinct forms.

THE MODERN MINOR, as it is generally called, is represented in Tonic Sol-fa Notation by the notes

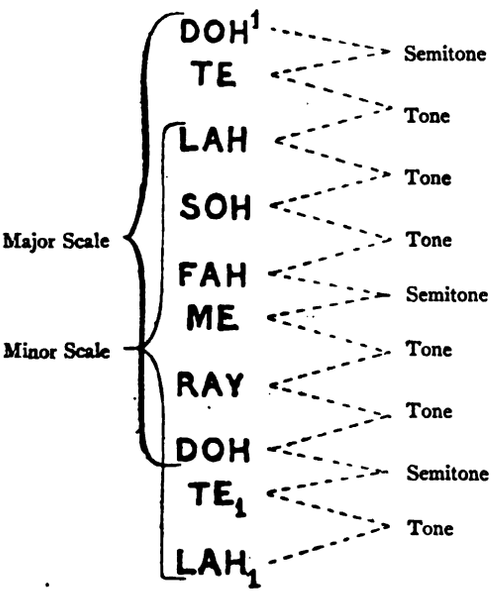
$l_1\ t_1\ d\ r\ m\ f\ s\ l,$

and various modifications of some of these notes.

LAH is regarded as the *Tonic* or *Key-note*, while *DOH*, the Tonic of the Major Scale, is the Minor Third of the Minor Scale.

The Scale of *DOH* and the scale of *LAH* (a minor third below or a major sixth above) are said to be *Relative* to each other. Thus, in the Major Scale of C, *LAH* is A, and the Scale or Key of A minor is said to be the *Relative Minor* of the Scale or Key of C Major: and similarly, the Scale or Key of C Major is said to be the *Relative Major* of the Scale or Key of A Minor.

The relation of the two scales may be shown thus :—



Taking $l_1\ t_1\ d\ r\ m\ f\ s\ l$ as forming our typical minor scale, let us see how this scale is modified, and under what conditions these modifications take place.

The Minor Scale (like the Major) comprises two Tetrachords; the *lower* tetrachord $l_1\ t_1\ d\ r$ and the *upper* tetrachord $m\ f\ s\ l$. Except in one peculiar case, the lower tetrachord is *fixed*, always consisting of the same four notes; but the upper tetrachord is *variable.*

In the *first* form of the Minor Scale (sometimes called Minor *Mode*), the upper tetrachord is—

ascending **m f s l**
and descending **l s f m**

This may be called the *ancient* or unaltered form. Harmony requires a *leading-note* a semitone below the Tonic. Now *SOH* is a full-tone below *LAH*, and must therefore be *sharpened a semitone* to *SE*, which is the leading-note in the Minor Scale.

The second form is therefore—

ascending **m f se l**
descending **l se f m**

This is the *true* form, or the *Harmonic form*; in other words, it is the form required by Harmony.

Observe, however, the peculiar interval between *FAH* and *SE*. This interval, called an augmented second, is so difficult to sing that *FAH* is often sharpened a semitone also. The new note is not called *FE*, as you might perhaps expect, but *BAH*. (Observe that *FE* is the *ordinary* sharp of *FAH*, and that *BAH* is the sharp of *FAH* used only in the Minor Scale.)

The third form of the Minor *ascending* is

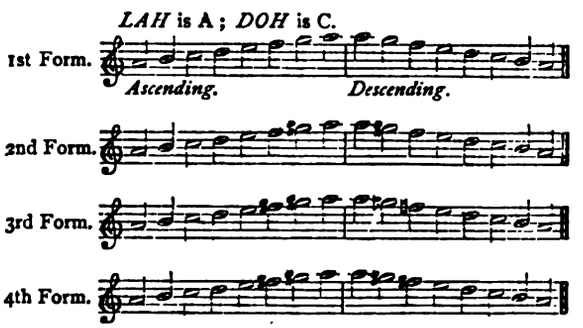
m bah se l

which is identical as to interval with the upper tetrachord of the Major Scale, **s l t d¹**.

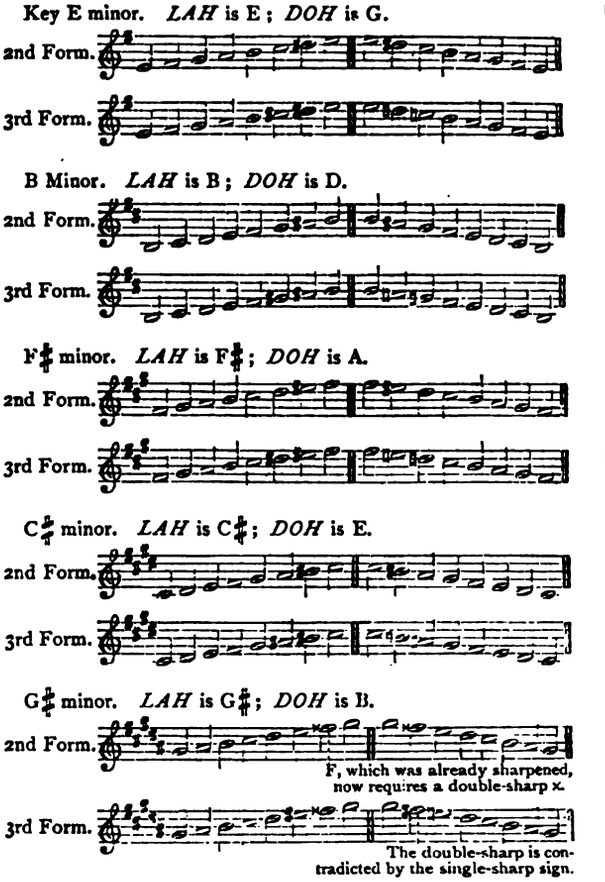
The tetrachord of this third form is generally **l s f m** (like the unaltered form): though, occasionally, **l se bah m** may be used, thus giving rise to a *fourth* form.

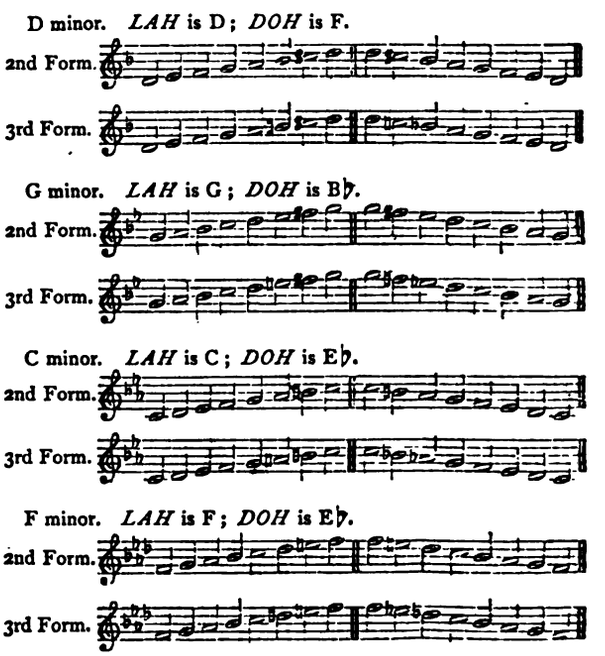
MINOR SCALE OR MODE.

1st Form.	*Ascending.*	l,	t,	d	r	m	f	s	l
	Descending.	l	s	f	m	r	d	t,	l,
2nd Form.	*Ascending.*	l,	t,	d	r	m	f	se	l
	Descending.	l	se	f	m	r	d	t,	l,
3rd Form.	*Ascending.*	l,	t,	d	r	m	ba	se	l
	Descending.	l	s	f	m	r	d	t,	l,
4th Form.	*Ascending.*	l,	t,	d	r	m	ba	se	l
	Descending.	l	se	ba	m	r	d	t,	l,

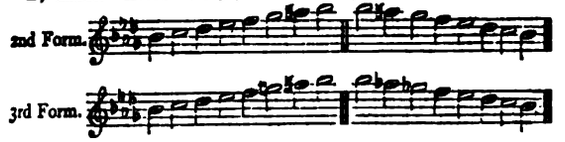
In Staff Notation, Key A Minor, these forms appear as follows:—

N.B.—The 1st, 2nd, and 4th forms are the same ascending and descending.

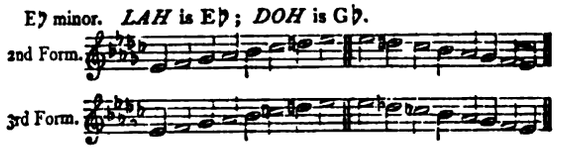
The following is a table of the Minor Scales most usually employed. The Second and Third Forms only are given, but the student will have no difficulty in writing the others for himself.

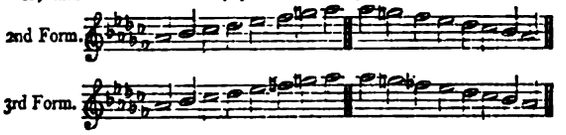

Key E minor. LAH is E; DOH is G.
2nd Form.
3rd Form.
B Minor. LAH is B; DOH is D.
2nd Form.
3rd Form.
F♯ minor. LAH is F♯; DOH is A.
2nd Form.
3rd Form.
C♯ minor. LAH is C♯; DOH is E.
2nd Form.
3rd Form.
G♯ minor. LAH is G♯; DOH is B.
2nd Form.
F, which was already sharpened, now requires a double-sharp ×.
3rd Form.
The double-sharp is contradicted by the single-sharp sign.

It is unnecessary to give the Scales of D sharp minor and A sharp minor; but the student is advised to practise writing them.

D minor. LAH is D; DOH is F.
2nd Form.
3rd Form.
G minor. LAH is G; DOH is B♭.
2nd Form.
3rd Form.
C minor. LAH is C; DOH is E♭.
2nd Form.
3rd Form.
F minor. LAH is F; DOH is E♭.
2nd Form.
3rd Form.

B♭ minor. *LAH* is B♭; *DOH* is D♭.



E♭ minor. *LAH* is E♭; *DOH* is G♭.

A♭ minor. *LAH* is A♭; *DOH* is C♭.



The student will remember that, in Major Scales, the semitones invariably occur between the *third and fourth* and between the *seventh and eighth* notes. In Minor Scales the semitones vary in position and number, according to the *form* of the scale.

Thus, in the *first* form l, t, d r m f s l they occur between the *second and third* and between the *fifth and sixth;* in the *second* form

l, t, d r m f se l,

they occur between the *second and third*, between the *fifth and sixth*, and between the *seventh and eighth*. In this form of the Minor Scale there is one interval larger than a tone, viz., the interval from *FAH* to *SE*. On account of this *Chromatic* interval (an augmented second), the second form of the Minor Scale is called by some theorists the *Chromatic Form.*

In the *third* form, ascending, l, t, d r m bah se l, the semitones fall between the *second and third* and between the *seventh and eighth;* descending,

l s f m r d t, l,

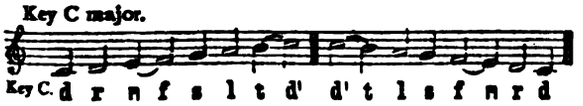
between the *sixth and fifth* and between the *third and second.*

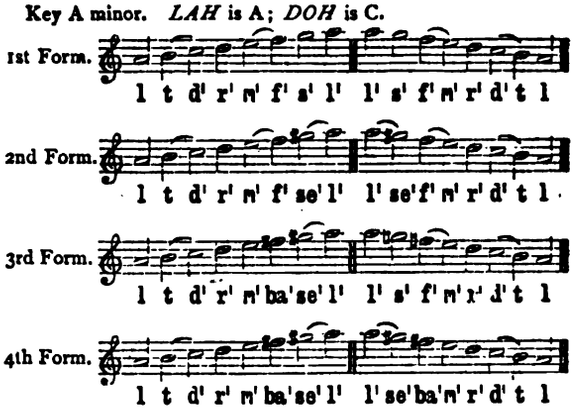
The student will perceive that Relative Major and Minor Keys have the *same signature.*

Thus, A Major and F♯ Minor are Relative Keys, both having the signature etc.

The terms TONIC MAJOR and TONIC MINOR are used to signify keys with the same Key-note or Tonic; as C Major and C Minor, F Major and F Minor, etc. Thus, while the Relative Minor has the *same signature* as its Relative Major, the *Tonic* Minor has *three flats more* or *three sharps less* in the signature than its Tonic Major.

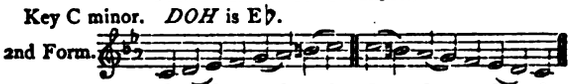
Study carefully the following, and go through all the other scales in the same way.

Key C major.

RELATIVE MINOR.

Key A minor. *LAH* is A; *DOH* is C.

1st Form. l t d' r' m' f' s' l' l' s' f' m' r' d' t l
2nd Form. l t d' r' m' f' se' l' l' se' f' m' r' d' t l
3rd Form. l t d' r' m' ba' se' l' l' s' f' m' r' d' t l
4th Form. l t d' r' m' ba' se' l' l' se' ba' m' r' d' t l

TONIC MINOR OF C MAJOR.

Key C minor. *DOH* is E♭.



(To be continued.)

—o—

Physiology.

BY ARTHUR NEWSHOLME, M.D. LOND.,

Gold Medallist and University Scholar, Physician to the City Dispensary.

CHAPTER VIII.—DIGESTION—*(continued).*

Prolonged boiling of casein or flesh, alone or with a dilute acid, produces a substance similar to and apparently identical with peptone. It would seem, therefore, that pepsin simply facilitates a change of hydration, which may be performed in its absence.

Peptones are not found in the circulation: they are absorbed by the capillary veins leading from the stomach to join the portal vein, which enters the substance of the liver. They are not present in the blood of the portal vein, (M. Foster.) It would seem, therefore, that peptones become changed again into albuminoids, immediately after their entry into the blood.

Various circumstances affect the rapidity and ease of gastric digestion. The greater the surface exposed to the action of gastric juice, and the more quickly solution of the food occurs. Thus fine division of food by mastication or other means, and constant movement of it, aid digestion. The presence of a large excess of the products of digestion impedes digestion. Neutralisation of gastric juice arrests it entirely; and it is most active with a juice, the acidity of which is ·02 per cent. It is most active at a temperature between 35 and 40° Cent.; very hot and very cold liquids are, therefore, harmful. The activity of artificial gastric juice is entirely destroyed by boiling for a few minutes.

The mental condition has an important influence on digestion. Worry or bad temper commonly produce indigestion. Exercise immediately after meals is injudicious; and so likewise is an immediate return to brain work, as these direct the flow of blood away from the digestive organs. The stomach ought to be fairly filled, but not distended. The French plan of having only breakfast and dinner, and these necessarily large meals, is not advisable; the best division is into three meals a day, at fairly equal intervals; allowing about five hours intervals between them, in order that the stomach may become quite empty.

There are two factors concerned in gastric digestion: First, the *chemical* action already considered; and, secondly, a *mechanical* action due to the movements of the stomach. The gastric movements are essentially identical to the peristaltic movements of the intestines, but modified by the peculiar arrangement of the muscular fibres in the stomach. A sort of churning is produced of the contents of the stomach, the food being carried from the cardiac orifice, along the greater curvature and back along the lesser curvature of the stomach, while subsidiary currents keep up a circulation of food between the centre of the stomach and the mucous membrane. The pyloric orifice is tightly closed by the contraction of the involuntary fibres forming the pyloric sphincter, and thus the escape of food into the duodenum is prevented. As gastric digestion advances, the pyloric sphincter gradually relaxes, and more and more of the products of gastric digestion escape. The movements of the stomach gradually increase in force as digestion proceeds, and the acidity of the gastric juice increases in an equal proportion. The exact character of the nervous mechanism governing the gastric movements is very doubtful. It is probably some ganglionic apparatus in connection with the sympathetic system. Section of both pneumogastric nerves causes spasmodic closure of the cardiac orifice of the stomach and accumulation of food in the œsophagus.

The chyme resulting from gastric digestion after leaving the stomach enters the small intestine, where it is subjected to other digestive changes. It will be convenient at this point to describe the structure of the small and large intestine, and of the glands appended to them, the liver and pancreas.

The *small intestine* forms a convoluted canal, commencing at the pylorus, and ending in the large intestine, at the ileo-cœcal valve. It is about twenty feet long in the adult, and its convolutions occupy the middle and lower part of the abdomen, surrounded by the large intestine (Fig. 35). It is arbitrarily divided into three parts, the first ten or twelve inches being called the *duodenum*, in the concavity of which lies the pancreas, the upper two-fifths of the remainder being named the *jejunum*, and the lower three-fifths the *ileum*. Like the stomach, the small intestine has four coats, serous or peritoneal, muscular, submucous, and mucous. The *serous* coat embraces the whole of the small intestine, except a part of the duodenum. The *muscular* coat consists of unstriped muscular fibres arranged in two sets, an outer longitudinal and an inner circular. The progressive contraction of this coat from above downwards causes the vermicular or peristaltic movements, by means of which the contents of the bowel are forced onwards. The movements of the intestine occur in a wave-like manner, and involve movements of individual parts, and also a frequent change of position of the whole. The *submucous* coat consists of areolar tissue, and connects the mucous and muscular coats together.

The *mucous membrane* shows on its inner surface a finely flocculent appearance, due to minute prominences studding its surface, called 'villi.' It is extremely vascular, one of the most vascular membranes in the body. Like the stomach, it is coated throughout with a single layer of columnar epithelium; and in its deepest part, next to the submucous coat, is bounded by a layer of unstriped muscular fibres (*muscularis mucosæ*). Between these parts it consists chiefly of tubular glands and retiform tissue, containing abundant vessels and lacteals.

Like the stomach, the mucous membrane presents folds, but, unlike that organ, its folds are not obliterated by distension. These folds, called *valvulæ conniventes*, reach transversely across the bowel from one-half to two-thirds of its circumference. Their largest amount of projection is about $\frac{1}{3}$ inch. Each consists of a fold of the mucous membrane, with some submucous tissue between the two layers. The valvulæ conniventes commence an inch or two beyond the pylorus, becoming much more numerous in the upper half of the jejunum, when the distance between them is not greater than the breadth of one of the valves. Below this point they gradually diminish in size, disappearing entirely about the middle of the ileum. They serve to supply a greatly increased mucous surface for digestive purposes, and for the absorption of digested food; and prevent the food from being hurried along too quickly.

The *villi*, already named, occur only in the small intestine, giving its surface a characteristic velvety appearance. They can be best seen by removing a piece of intestine from a rabbit, washing it carefully, and then examining it with a pocket lens under a shallow layer of water. The water serves to float up the villi. Each villus is $\frac{1}{36}$ to $\frac{1}{48}$ of an inch in width, or more. In the upper part of the small intestine they have been estimated to number from 600 to 1000 in a square inch, and in the lower part from 480 to 800 in the same space. Krause calculates their total number as at least four millions.

Each villus is practically a prolongation upwards of the mucous membrane. Its free surface is covered by columnar epithelium; inside this is a delicate basement membrane, on which the columnar cells rest; the rest of the villus being occupied by retiform tissue, supporting the ultimate branches of a minute artery, a few unstriped muscle fibres, and one or more lacteal vessels. Minute twigs of nerves are probably also present in the villus. The lacteal vessel lies in the middle of the villus, and either ends in a blind dilated extremity, or there may be two lacteals ending in a loop. The epithelioid cells of the lacteal vessel are continuous with the branched cells of the retiform tissue, and these with the flattened cells of the basement membrane; and it is probable that prolongations from the last-named cells extend between the columnar cells towards the mucous surface. It is possible that the emulsified fat is absorbed by means of these processes into the lacteals; but, according to some authorities, the columnar cells absorb the fat in an amœboid fashion, and then give it up to the lacteal on their opposite side. The muscular tissue in the villus probably serves to retract the villus and drive the contents of the lacteal vessel into a larger lacteal vessel (Fig. 38) in the submucous tissue, where it joins other lacteal vessels, and finally forms the thoracic duct.

Tubular glands (crypts of Lieberkühn) are found throughout the small and large intestine. They are similar to those in the stomach, only they are never divided. They are simple prolongations downwards of the mucous membrane, lined like the general surface with columnar epithelium; they vary in length from $\frac{1}{30}$ to $\frac{1}{10}$ of a line, and have a diameter of about $\frac{1}{50}$ line.

Brunner's glands, named after the anatomist who first described them, are almost entirely confined to the duodenum. They present transitional forms

between compound racemose and compound tubular glands, and have essentially the same structure as

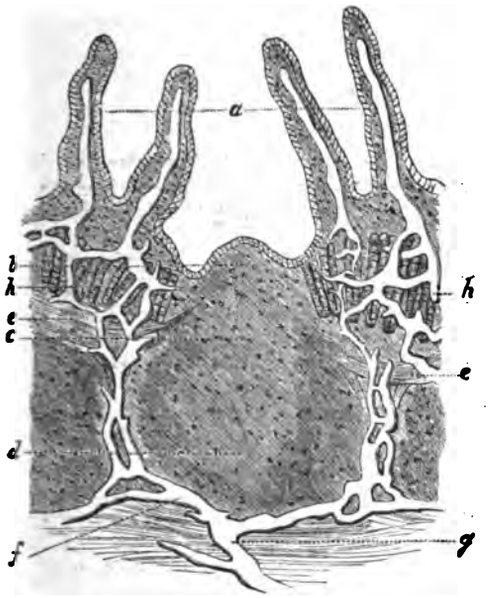


Fig. 38.—Closed Follicle, Villi, and Lacteal Vessels of Small Intestine. Vertical section, magnified 30 times
(*a*) Villi enclosing Lacteal Vessels. (*b c d*) Closed Follicle. (*e*) Muscularis mucosæ. (*f g*) Larger Lacteal Vessels. (*h*) Crypts of Lieberkuhn.

small salivary glands, or as the pancreas. Their lower ends are embedded in the submucous coat.

Closed follicles occur in two forms in the small intestine. 1st, *solitary glands*, and 2nd, *agminated glands*, or glands of Peyer. The structure in the two cases is identical. Each follicle is about the size of a millet-seed, and is composed of retiform tissue, in the meshes of which are embedded numerous lymphoid cells, the whole tissue being traversed by fine capillaries. The follicle is situated chiefly in the submucous tissue, but causes a slight bulging upwards of the mucous membrane; and at this part it is studded all over with villi, while around it the orifices of tubular glands are seen (Fig. 38).

Agminated glands are composed of groups of these lymphoid follicles, each group being arranged lengthwise along the intestinal wall, thus forming an oblong figure, from half to two, or even four inches long. The agminated differ from the solitary follicles in having no villi on their surface. There are thirty or more of them in the whole course of the small intestine.

The *large intestine* extends from the termination of the ileum to the anus. It is divided into the cœcum, colon, and rectum. Its length is about 5 or 6 feet, or one-fifth of the whole length of the intestine. It has a much larger diameter than the small intestine; and in addition to this feature, it can be distinguished from the small intestine by the occurrence of constrictions at varying intervals, causing the bowel to have a sacculated appearance, and by the presence of three longitudinal bands of muscular tissue.

The *cæcum* is that part of the large intestine situated below the point of junction of the small and large intestine. It is about $2\frac{1}{2}$ inches long, and is situated in the lowest part of the abdomen on the right side. Coming off from its inner and back part is a tapering diverticulum about the size of a large quill, and 3 to 6 inches long, called the *appendix vermiformis* (Fig. 35). Small foreign bodies such as cherry-stones, may become impacted in this cul-de-sac, and even perforate through its coats, with a fatal result. The *ileo-cæcal valve*, preventing return of the intestinal contents from the large into the small intestine, is composed of two segments which project inwards towards the cœcum, formed of prolongations of the mucous and muscular coats of the ileum. The cœcum is the point at which, when constipation occurs, fæces are apt to get impacted. It will be noticed that the course the intestinal contents have to take after leaving the cœcum is upwards along the ascending colon. The long retention of fæces in the cœcum is apt to lead to inflammation of its coats, and occasionally perforation through them. After the cœcum, the *ascending colon* reaches up to the under surface of the liver; it then stretches across the upper part of the abdomen as the *transverse colon*, and descends on the left side as the *descending colon*, forming at its lower part a *sigmoid* (S-like bend), and then becoming the *rectum*, which is the terminal part of the bowel. The lower part of the rectum is protected by two sphincters, an internal sphincter not under the control of the will, and an external sphincter controllable by the will. Other voluntary muscles attached to the lower end of the alimentary canal, and to the bones at the lower margin of the pelvis, have an important part to play in the extrusion of the fæces.

The large intestine has four coats, similar to those of the stomach and small intestine, but differing in minor respects. The *serous* coat is absent over the lower part of the rectum. The *muscular* coat consists, as in the small intestine, of internal, circular, and external longitudinal fibres, but the longitudinal fibres are chiefly collected into three longitudinal bands, except in the rectum, where they spread out over the whole surface of the intestine The *submucous* coat resembles that of the small intestine. The *mucous membrane* differs from that of the small intestine in being smooth and destitute of villi. It presents similar tubular glands to those of the small intestine, only longer and more numerous. Its lymphoid follicles are similar to the solitary follicles of the small intestine, but less prominent.

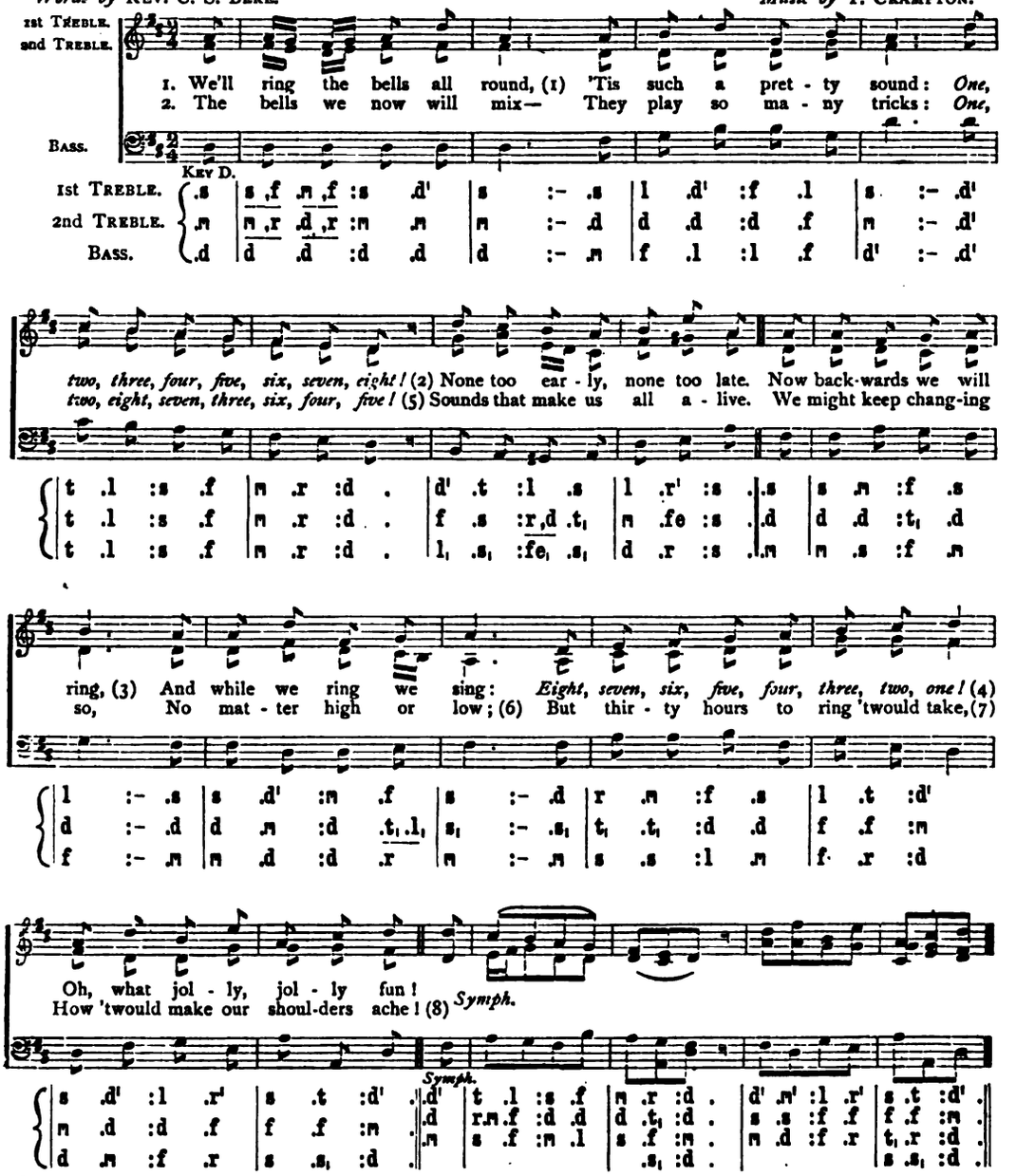
(*To be continued.*)

GERMAN SCHOOL SINGING.—Mr. J. S. Curwen has published a report on his investigations in elementary schools in Cologne, Munich, Vienna, and Basil, last summer. These towns, in the order in which he happened to visit them, represent an ascending scale of proficiency in singing. The weak point of the whole is that the study of even the elements of musical notation is postponed until the child is ten years of age, and has probably been singing by ear, in the Kinder-Gartens and lower standards, for six or seven years. By this means the habit of trusting to the ear is formed, and even the elder children, who understand the powers of the notes, and hold the music in their hands, prefer to sing by ear. Such a state of things contrasts unfavourably with the Tonic Sol-fa system, by which children of five may, without any strain, be taught to associate sign and sound in an intelligent manner. Mr. Curwen speaks highly of the artistic results obtained. The singing is chiefly done by ear, and the pieces are prepared with much labour, but they are beautifully finished in style. In Switzerland the teaching of notation is well graded, and fair results are obtained.

THE BELLS!

Drill Song.

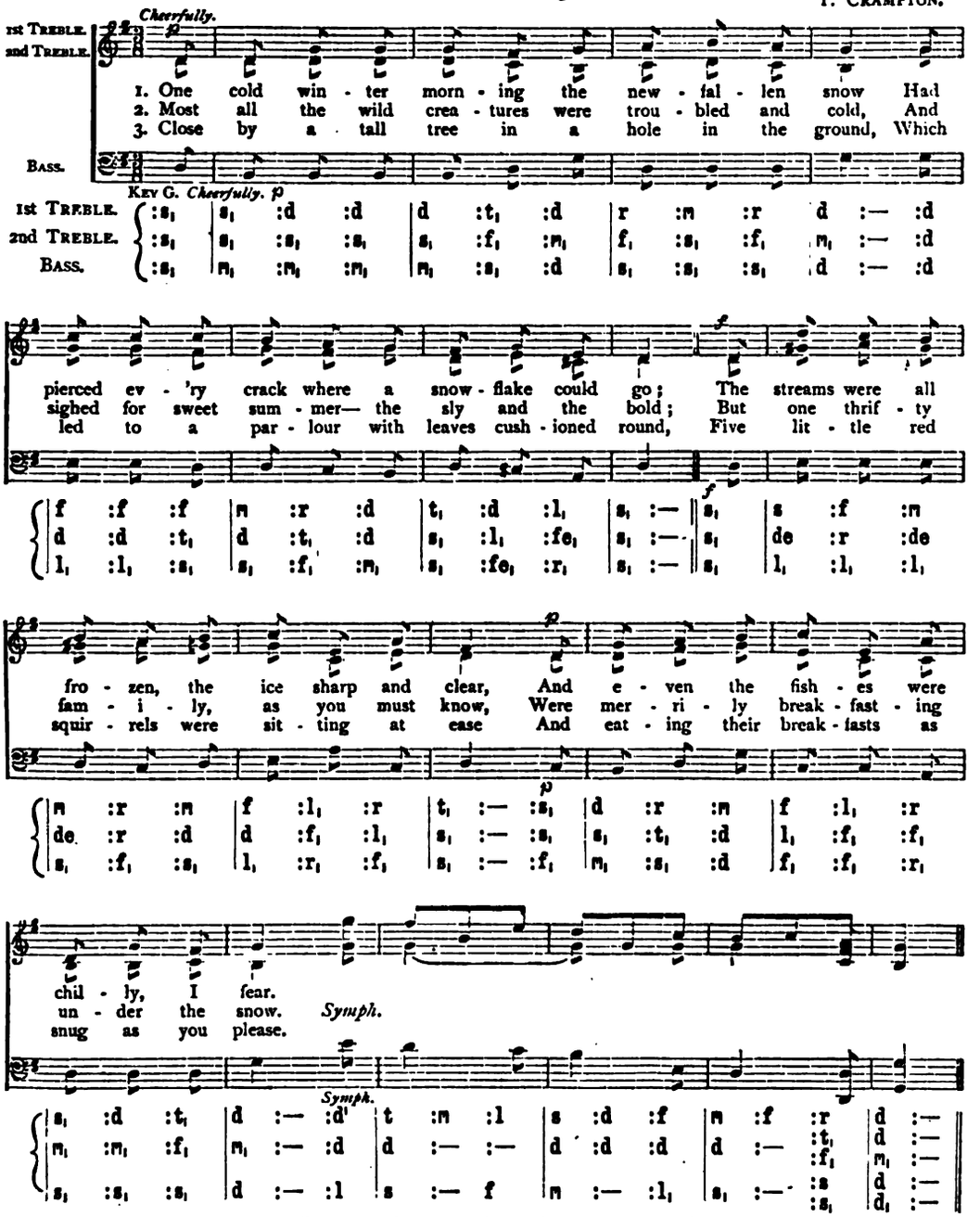
Words by REV. C. S. BERE. *Music by* T. CRAMPTON.


1st TREBLE.
2nd TREBLE.
BASS.
1. We'll ring the bells all round, (1) 'Tis such a pret - ty sound: One,
2. The bells we now will mix— They play so ma - ny tricks: One,
KEY D.
1st TREBLE.
2nd TREBLE.
BASS.
two, three, four, five, six, seven, eight! (2) None too ear - ly, none too late. Now back-wards we will
two, eight, seven, three, six, four, five! (5) Sounds that make us all a - live. We might keep chang-ing
ring, (3) And while we ring we sing: Eight, seven, six, five, four, three, two, one! (4)
so, No mat - ter high or low; (6) But thir - ty hours to ring 'twould take, (7)
Oh, what jol - ly, jol - ly fun!
How 'twould make our shoul-ders ache! (8)
Symph.
Symph.

(1) Hold up hands, left over right, as if at bell-ropes. (2) If there be eight scholars, bring down hands in order; if sixteen, two at each pull. (3) As in (1). (4) As in (2), only backwards. (5) Ditto. (6) Hands first up, then down. (7) Motion of surprise. (8) Rub shoulders.

THE SQUIRRELS.*

A Winter Song.

T. CRAMPTON.

Cheerfully.
1st Treble.
2nd Treble.
Bass.
1. One cold win - ter morn - ing the new - fal - len snow Had
2. Most all the wild crea - tures were trou - bled and cold, And
3. Close by a tall tree in a hole in the ground, Which
Key G. Cheerfully.
1st Treble.
2nd Treble.
Bass.
pierced ev - 'ry crack where a snow - flake could go; The streams were all
sighed for sweet sum - mer— the sly and the bold; But one thrif - ty
led to a par - lour with leaves cush - ioned round, Five lit - tle red
fro - zen, the ice sharp and clear, And e - ven the fish - es were
fam - i - ly, as you must know, Were mer - ri - ly break - fast - ing
squir - rels were sit - ting at ease And eat - ing their break - fasts as
chil - ly, I fear.
un - der the snow.
snug as you please.
Symph.
Symph.

*The teacher will suggest a few appropriate actions to the words of this song.

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The New Class-Subject, 'Elementary Science.'

(What to teach, and how to teach it.)

BY RICHARD BALCHIN.

IN last month's issue of this magazine will be found a syllabus of a course of sixty lessons on this subject, for Standard III. It is assumed that 'Hughes' Science Readers' will be used in conjunction with this course, for the syllabus is arranged mainly upon the contents of that book. I may here state, parenthetically, that I have been asked by letter, this week, whether I 'know for certain that H. M. Inspector will accept this book, seeing that it does not in its present form contain 120 pages of printed matter and sixty lessons.' In answer to this, I reply that one of the largest schools in South London takes Elementary Science as one class-subject and uses this particular book. The examiner questioned from the book; was delighted with it, and with the intelligence shown in the boys' answers; gave 'excellent' for the merit grant; and, furthermore, the School-management Committee of the London School Board have assessed the report as 'excellent.'

I now propose giving the subject-matter, or bare outlines, of the easy conversational lessons in the syllabus to which I have alluded. The reader will observe that many of the titles have already appeared in the plan of lessons for Standard II. This apparent repetition is, however, inevitable. The teacher will, of course, know how to expand the subject, so as to suit the general intelligence of the children in this higher standard.

LESSON 1.—'THE THREE KINGDOMS.'

Objects exhibited: Pictures of trees and animals. A few stones. A flower growing in a flower-pot, and a tumbler of water.

Animals and vegetables live, feed, and die, *i.e.*, are *animate*. Minerals, *in*animate. Distinguish between animal and vegetable life: (1) As to the nature of their respective foods; (2) As to mode of obtaining that food; (3) Other points of difference.

Vegetable food is inorganic, or earthy; *i.e.*, mineral. Animal food is organic. Animals wander in search of food. Vegetables must have it supplied on the spot. (If the plant in the flower-pot is withering for want of water, *i.e.*, dying of thirst, it is no use placing a tumbler of water by its side; but a thirsty boy can walk *to* the tumbler, reach out his hand and drink.) Plants are never warmer than the air around them; living animals are.

Note.—These distinctions, although open to exception, yet embody sufficient truth for our present purpose.

LESSON 2.—CLASSIFICATION.

Objects exhibited: A chart showing classification of natural objects: this was described in Standard II. lessons; and is given on p. 59 of 'Science Reader for Standard III.'

Classification places *like* objects in groups. An object in one class is like others in that class, but unlike those in other classes. Carry the classification of words further than in Standard II., but adopt the same method of using slips of paper as described in a former article of the PRACTICAL TEACHER. Give a classification of an object for which the neighbourhood may be specially noted, *i.e.*, different kinds of coal; or of iron ore; or of skins for tanning, etc.

LESSON 3.—THE MINERAL KINGDOM: ROCKS AND METALS.

Objects exhibited: Specimens of stones and of metals. Pictures of a stone quarry, *i.e.*, the slate quarries at Penryn; and of a metalliferous mine, *i.e.*, a Cornish tin-mine.

Distinguish between a stone and a metal. A metal (*i.e.*, lead) malleable; fusible; cut-surface bright; same composition throughout its mass; occurs in ores in *veins* or *lodes*. These are cracks in rocks into which has filtered water containing the metalliferous substance in solution. Contrast with rock-masses in these particulars.

LESSON 4.—SANDSTONE.

Objects exhibited: Specimens of different kinds of sandstone; (1) coarse, *i.e.*, millstone grit; (2) fine, *i.e.*, stones for sharpening tools; hammer, and slab of stone.

Sandstone; why so called. Powder up a piece of paving-stone to sand. How formed; show the lines of deposit along the broken edge of the sandstone. The lines are probably lines of mica. Show how this happens, thus:—mix some finely-divided mica with a handful of sand; throw a portion of the mixture into a large glass jug of water: note how the sand settles first; then the mica, which forms a *layer* on the sand. Now throw in the remaining part of the mixture: the sand settles on the previously-formed layer of mica, and so on.

Red sand; white sand (for glass making).

LESSON 5.—GRANITE.

(The notes of this lesson have already been fully given in Standard II. course.)

LESSON 6.—LIMESTONE.

Objects exhibited: Specimens of Bath and Portland oolites. Chalk, white marble, Kentish rag, etc. Some spirits of salts (H.Cl.). Pictures of chalk pit, and of limekiln.

Limestone; why so called, *i.e.*, when burnt, it forms quicklime. Bad air burnt out. Show picture of limekiln. Pour some H.Cl. on a piece of limestone, bad air comes out in bubbles. (If the class is tolerably intellectual, use the terms carbon dioxide, or carbonic acid gas, instead of 'bad air.') Not good to live near a limekiln; why? Lime used in making mortar—bad mortar has little lime—and in the smelting of iron. Chalk is very soft limestone; sometimes find shells and corals, even sharks' teeth, in chalk; this teaches how chalk is formed. So lead to the formation of beds of limestone.

LESSON 7.—SLATE.

Objects exhibited: Small block of slate, to be split up. Slate pencil. Some powdered slate. Picture of slate quarry. If possible, a piece of slate with the fossil named 'a trilobite.'

Show picture, and carry on a conversation about it. Split up a piece of slate into plates. Uses:—roofs of houses, cisterns, etc. Mix some water with powdered slate and so make a 'mud,'—some 'gutter' boy will be glad to do this. Slate was originally like this mud. Show the remains of a sea animal in a block of slate; and thus lead to the formation of slate.

Note.—The subject-matter of Lessons 8, 9, 10, and 11 is fully given in Chapter III. of the 'Science Reader.'

LESSON 12.—IRON.

Objects exhibited: Specimens of cast-iron, wrought iron; iron-ore, slag, mountain-limestone. Pictures of iron mine, and of a blast furnace.

Iron ores. Hæmatite; black-band, clay-band; operations—(1) Roasting the ore. (2) Smelting. Materials for blast-furnace mixed in the following proportion:—Roasted black band, 4½ cwt.; Roasted clay-band, 4½ cwt.; Limestone—as a flux—2 cwt.; coal, 10 cwt. Pig or cast-iron produced. (3) Puddling, *i.e.*, removal of carbon from cast-iron; and so wrought iron is produced.

Note.—These processes are described in Chapter VII. of the 'Science Reader for Standard IV.'

LESSON 13.—TIN.

Objects exhibited: Specimens of the various kinds of tin-ore; of the pure metal; of sheet-tin. Picture of a Cornish tin-mine.

Show specimen of ore, *i.e.*, a heavy grey stone—tinstone: sometimes red—red tin-ore. Explain a metallic vein as before. In Cornwall the cracks are generally in granite; sometimes the cracks cross each other. The tin-ore is first washed in a stream of water; then broken up small in the stamping mill; then again washed in water: then the ore is 'roasted' in a furnace where only the *flame* of the furnace comes in contact with the ore; the heat not being sufficient to melt the metal. Lastly, the roasted ore goes to the smelting furnace, where the nearly pure tin is melted out of the ore and sinks to the bottom of the furnace.

Tin is used in alloys; *i.e.*, bronze, bell-metal, solder. Mostly, however, in the manufacture of sheet-tin; or rather iron plates covered with tin. The tin does not cover the iron as a separate coating, but partly enters into its substance as an alloy.

Note.—The subject matter and methods of Lessons 14, 15, 16, and 17 are given with sufficient fulness on p. 30 of the 'Reader.'

LESSON 18.—A PLANT AND ITS PARTS.

Objects exhibited: Four or five pictures of trees, shrubs, and common annuals. A few dried specimens mounted on card-board.

Carry on a conversation about the pictures and specimens. Note that in all of them we have certain parts: *i.e.*, leaves, stems or trunks, small shoots or branches, flowers or seeds, roots, etc. Then describe the parts noticed, in the following order—(1) Root: its use to the plant, and also as food for man and other animals. (2) Stem or trunk; use to the plant, to bear up the leaves and flowers; to man as yielding timber. (3) Leaves; uses to the plant, and also to man. (4) The flowers; uses: the formation of seeds and beautifying the earth.

Note.—The subject-matter of Lesson 19 (the primrose) and Lesson 20 (flowering and flowerless plants) is given on pages 32 to 38 of the 'Reader.'

(*To be continued.*)

ANSWERS TO ALGEBRA QUESTIONS IN 'THE SCHOLAR,' FOR MARCH, 1884.

EXERCISE XXIX.

(1) $x=4,\ y=5$	(2) $x=2,\ y=2$
(3) $x=8,\ y=10$	(4) $x=-1, y=1$
(5) $x=4,\ y=5$	(6) $x=2,\ y=1$
(7) $x=7,\ y=4$	(8) $x=3,\ y=4$
(9) $x=5,\ y=7$	(10) $x=30, y=41$
(11) $x=10, y=9$	(12) $x=3,\ y=5$
(13) $x=5,\ y=2$	(14) $x=10, y=13$
(15) $x=44, y=35$	(16) $x=3,\ y=2$

ANSWERS TO
Pupil Teachers' Examination Papers.

JANUARY 26.

FIRST YEAR.

Pupil Teachers at end of First Year.

Three hours and a half allowed.

Arithmetic.

MALES.

1. $\dfrac{3\frac{3}{4}\text{ of }2\frac{1}{7}-1\frac{4}{9}}{\frac{1}{2}+\frac{1}{3}-\frac{1}{4}}\div\dfrac{2\frac{3}{5}}{2\frac{2}{3}}$

$$\frac{3\frac{3}{4}\text{ of }2\frac{1}{7}-1\frac{4}{9}}{\frac{1}{2}+\frac{1}{3}-\frac{1}{4}}\div\frac{2\frac{3}{5}}{2\frac{2}{3}}=\frac{\frac{15}{4}\text{ of }\frac{15}{7}-\frac{13}{9}}{\frac{13}{12}}\div\frac{\frac{13}{5}}{\frac{8}{3}}$$

$$=\frac{\frac{45}{7}-\frac{13}{9}}{\frac{6+4-3}{12}}\div\frac{13\times8}{5\times21}$$

$$=(\tfrac{314}{63}\div\tfrac{7}{13})\div\tfrac{104}{105}$$

$$=\frac{481\times12\times105}{72\times7\times104}=\tfrac{1443}{126}=11\tfrac{57}{126}.\text{ Ans.}$$

2. Convert $\frac{6}{13}$ and $\frac{5}{72}$ into decimals, and then divide the difference of the results by ·00385 to 3 decimal places.

$\frac{6}{13}$ = ·0888888
$\frac{5}{72}$ = ·078125

·00385)·0107638(2·795. Ans.
770
3063
2695
3688
3465
2238
1925
.....

3. Reduce ·7 of £·875 + ·0625 of a crown − ·083 of a guinea to the decimal of 13s. 4d.; and find the value of ·76136 of 5 acres 2 roods.

(*a*)

	£ s.
£·875 × ·7 =	12 25
·0625 cr. =	·3125
Sum =	12·5625
Deduct ·083 guineas =	1·75
	10·8125

10·8125s. to the dec. of 13s. 4d. $=\dfrac{10\cdot8125\text{s.}}{13\frac{1}{3}}$

$$=\frac{32\cdot4375}{40}$$

$$=\underline{\cdot8109375}.\text{ Ans.}$$

(*b*)

$$\cdot76136\text{ of }5\tfrac{1}{2}\text{ ac.}=\tfrac{11}{2}\text{ ac.}\times\frac{75375}{99000}$$

$$=\frac{11\text{ ac.}\times8375}{2\times11000}=\frac{8\cdot375}{2}\text{ac.}$$

$$=4\cdot1875\text{ ac.}=\underline{4\text{ ac. }30\text{ po.}}\text{ Ans.}$$

4. A man spends $\frac{8}{15}$ of his money, and then earns 5s.; he afterwards spends $\frac{4}{7}$ of what he then has, and has 10s. 6d. left. How much had he at first?

10s. 6d. = $\frac{3}{7}$ of what he had after earning 5s.

$$\therefore\frac{10\text{s. }6\text{d.}\times7}{3}=\quad,,\quad,,\quad,,$$

$$=24\text{s. }6\text{d.}$$

Hence 24s. 6d. − 5s. = 19s. 6d. = $\frac{3}{15}$ of what he had at first.

And $\therefore\dfrac{19\text{s. }6\text{d.}\times16}{13}=$ what he had at first.

$$=\underline{\text{£}1\text{ 4s.}}\text{ Ans.}$$

FEMALES.

1. The books in a case can be arranged in rows of 5, 7, 9, or 15; how many are there?

The number of books is the L.C.M. of these numbers.
And the L.C.M. of 5, 7, 9, and 15 = 315. Ans.

2. Find the value of 219 cwt. 3 qrs. 21 lb. at £1 6s. 8d. per cwt.

£	s.	d.		
1	6	8	= value of 1 cwt.	
		219		
292	0	0	= ,,	219 ,,
0	13	4	= ,,	2 qrs. (2 qrs. = ½ cwt.)
0	6	8	= ,,	1 qr. (1 qr. = ½ of 2 qrs.)
0	3	4	= ,,	14 lb. (14 lb. = ½ qr.)
0	1	8	= ,,	7 lb. (7 lb. = ½ of 14 lb.)
293	5	0	= val. of 219 cwt. 3 qrs 21 lbs.	

3. Find the difference between $\frac{4}{9}$ and $\frac{3}{11}$.

$$\tfrac{4}{9}-\tfrac{3}{11}=\frac{44-27}{99}=\tfrac{17}{99}.\text{ Ans.}$$

4. Find the value of 9 yds. 2 ft. 3 in. at 5s. 7d. per yard.

£	s.	d.		
0	5	7	= price of 1 yd	
		9		
2	10	3	= ,, ,,	9 yds.
0	1	10½	= ,, ,,	1 ft. (1 ft. = ⅓ of a yd.)
0	1	10½	= ,, ,,	1 ft. (1 ft. = ⅓ ,, ,,)
0	0	5$\frac{7}{12}$	= ,, ,,	3 in. (3 in. = ¼ of 1 ft.)
2	14	5½	= price of 9 yds. 2 ft. 3 in.	

5. Find the G.C.M. of 1729 and 5850.

2	1729	5850	3
	1326	5187	
1	403	663	1
	260	403	
1	143	260	1
	117	143	
2	26	117	4
	26	104	
	13		

∴ $\underline{13}$ = G C M. Ans.

Grammar.

MALES AND FEMALES.

'His grandeur he derived from Heaven alone,
For he was great, ere Fortune made him so;
And wars like mists that rise against the sun,
Made him but greater seem, not greater grow.

1. Analyse the first two lines of this stanza.
2. Parse the third and fourth lines.

1. ANALYSIS.

Sentence.	Kind.	Subject.	Predicate.	Object.	Extension.	Connective.
1. His grandeur he derived from heaven alone	Principal	he	derived	his grandeur	from heaven alone (*place*)	
2. For he was great	Subord. of cause to (1)	he	was great			for
3. Ere Fortune made him so.	Subord. of time to (2)	Fortune	made so (compl:)	him	so (indirect object or complement)	ere

2. PARSING.

And—copulative conj., connecting the two principal clauses.
wars—abst. noun, neut., plur , nom., subj. of 'made.'
like—predic. adj., qual. 'wars' (some consider 'like' a prep.)
mists—com. noun, neut., plur., obj., gov. by (to), or by 'like' if considered a prep.
that—simple rel., referring to 'mists,' 3rd pers. plur., neut., nom , subj. of 'rise.'
rise—intrans. irreg. verb, *rise, rose, risen*, indic., pres., indef., 3rd pers. plur., agr. with 'that.'
against—prep. showing rel. bet. 'rise' and 'sun,' and gov. the latter.
the—def. art., or dist. adj., limiting 'sun.'
sun—com. noun, neut., sing., obj., gov. by 'against.'
made—trans. irreg. verb, *make, made, made*, indic. past., indef., 3rd pers. plur., agr. with 'wars.'
him—demonst. pron., 3rd pers. sing., mas., obj., gov. by 'made.'
but—adv. of deg. mod. 'seem.'
greater—predic. adj., compar. deg., qual. 'him.'
seem—reg. intrans. verb, infin. pres., indef., gov. by 'made.'
not—neg. adv., mod. 'grow.'
greater—same as above.
grow—irreg. intrans. verb, *grow, grew, grown*, infin. pres. indef.

3. Take the four nouns, Heaven, Fortune, War, and Mist, and show how, by the addition of a syllable, each of them may be turned into an adjective. Give in each case two other words of like construction.

Heaven*ly*,	earth*ly*,	world*ly*.
Fortun*ate*,	passion*ate*,	desper*ate*.
War*like*,	God*like*,	fiend*like*.
Mist*y*,	ston*y*,	wood*y*.

4. Correct, if needful, these sentences, and give your reasons for altering them :—

'What went ye out for to see?'
'I wished to have seen you yesterday.'
'It was not me who did it.'

'What went ye out to see?' *For* should not be used before the infinitive.
'I wished *to see* you yesterday.' The present infinitive, and not the perfect, should be used after a past tense.
'It was not *I* who did it.' The verb *to be* and many intransitive and passive verbs when finite, have a *nominative* both before and after them.

Geography.

(*Answer either Question 2 or Question 3, not both.*)

1. Draw a full map of the western portion of the Dominion of Canada, including Lake Winnipeg, and all that lies to the west and north of it, Mark the chief mountain heights, rivers, and lakes.
N.B.—Insert the lines of latitude and longitude.

2. Give a short account of London, describing the different parts of it, the physical features of the surrounding country, and the habits and occupations of the people. Say what you know about its history.

The three principal divisions of London are: the City, in which its immense commerce is carried on; Westminster, the seat of the Courts and Parliament; and Southwark, on the south bank of the Thames. It has been so vastly extended as to embrace the adjacent villages (now grown to the size of cities)—Hackney, Islington, Spitalfields, Stepney, Rotherhithe, Camberwell, Kensington, Chelsea, and several others.
London is situated on that part of the Thames, where its basin of low clay is enclosed between ranges of hills, from which smaller streams are thrown down. To the north lie the Chilterns and the East Anglian uplands, to the south the North Downs, and further off the Wealden Heights. The largest part of it stands in Middlesex, the next largest in Surrey, a large part stretches into Kent, and another into Essex. Around it lie large grass farms, numerous market-gardens, and many brick-fields, from the bricks of which the houses of London are built.
It is impossible to speak of the varied occupations of the population of a city containing contributions from all the races and nationalities in the world. Among its people are to be found more wealth, more poverty, more charity, and more misery than can be found in any other single city on the face of the earth.
London existed in Druidical times, long before the arrival of the Romans. It was called Augusta by the Romans, and was the central point from which all the Roman roads in Britain diverged. After the Romans left, it became the capital of the East Saxons, and then that of England under Alfred. It obtained its first royal charter from William the Conqueror in the eleventh century.

3. 'Land of brown heath and shaggy wood!
Land of the mountain and the flood!'

—Which parts of Scotland answer best to this description? Show this by comparing them minutely with other parts of that country and with England.

The parts of Scotland which answer to this description are those lying in the north of the country, and cut off from the southern, or lowland districts, by the irregular masses of the Grampians, which extend from Argyll to Kincardine. No less than three-fourths of the entire surface of the land are covered with masses of gneiss, quartz, granite, and other rocks, which form mountains that in some cases reach to nearly double the height of the English heights, or widen into moorlands that lie 1000 ft. or higher above the level of the sea. The south of Scotland is hilly, but nothing to be compared with the north. The west coast is very much cut up by inlets, called 'lochs,' and these give Scotland a longer coast line, in proportion to its size than England. With the exception of Switzerland there is no country in Europe more remarkable for its lakes. Its highland streams generally partake of the nature of torrents, and when they are flooded their force is terrible.

History.

1. Which were the three dominant Saxon kingdoms? Describe their position.

The three dominant Saxon kingdoms were *Northumbria*, extending from the Firth of Forth to the Humber; *Mercia*, including the land east of the Severn, north of the Thames, south of the Humber; and *Wessex*, including the country west of the present Sussex, south of the Thames, except Devon and Cornwall.

2. Write down a list of sovereigns from Egbert to Athelstan, with dates, and give some account of one of them.

	A.D.	A.D.
Egbert reigned from	827	to 836
Ethelwulf ,, ,,	836	,, 857
Ethelbald ,, ,,	857	,, 860
Ethelbert ,, ,,	860	,, 866
Ethelred ,, ,,	866	,, 871
Alfred ,, ,,	871	,, 901
Edward I. ,, ,,	901	,, 925
Athelstan ,, ,,	925	,, 941

Alfred the Great, fourth son of Ethelwulf, was born at Wantage, in Berkshire. After the death of his three brothers he came to the throne in 871, and during a reign of thirty years he was constantly at war with the Danes. They were successful in making head against him. In 877 he was forced to disband his troops, and he retired to Athelney. During his wanderings the tales of his entering the Danish camp as a harper, and his adventure with the neatherd's wife, who scolded him for letting the cakes burn, etc., are well known. Having learnt the plans of his enemies, he defeated them at Ethandune, 878, recovered possession of London, and devoted himself to the improvement of his kingdom. In 896 he repelled a new Danish invasion, and died in 901.

3. How was the Witan composed, and what powers did it possess?

The Witan among the Anglo-Saxons was composed of Aethelings or princes, ealdormen or nobles, the large landholders, the principal ecclesiastics, etc. It was summoned by the king in any political emergency; and its assent was necessary to give validity to laws; and treaties with foreign states were submitted to its approval; it had even power to elect the king, and if the crown descended in his family, it was by means of the formal recognition of the new king by the nobles, bishops, etc., in an assembly convened for the purpose.

Dictation.

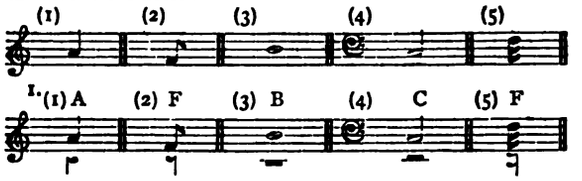
For Pupil-Teachers at the end of the 'First Year.'

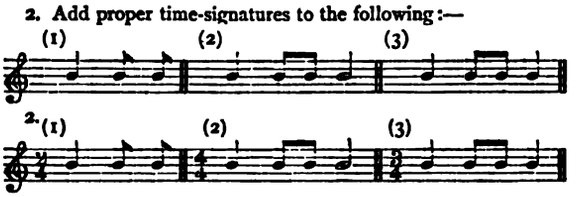
The following dismal description is given of the life of our primitive ancestors in Friesland, before the erection of their dykes and embankments against the German Ocean. 'Twice a day the tide rolls in and covers the land. The miserable natives get upon hillocks, or on artificial banks, which they have made after finding how high the water will rise. In their huts upon their banks they look, when the tide is in, like sailors on board ship, and like shipwrecked men when the tide ebbs; and round their huts they hunt the fish as they try to escape with the tide. They have no cattle, so that they cannot live on milk like other wild nations; nor can they even fight with wild beasts, when every stick is swept out to sea. They weave fishing-nets out of sea-tangle and rushes; and they pick up handfuls of mud, which they dry in the wind (for they have little sunshine), and so make a fire to scorch their food and to warm their stiffened bodies.'

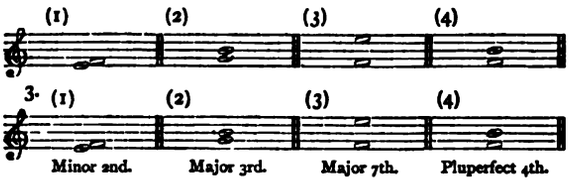
Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write above each of the following notes its pitch-name (C, D, &c.); and below write the signs for rests corresponding in value to the notes :—

2. Add proper time-signatures to the following :—



3. Write below each of the following intervals its name (major fourth, &c.) :—

TONIC SOL-FA NOTATION.

1. Write (1) a six-pulse tone, using two-pulse measure; and (2) a six-pulse tone, using three-pulse measure.

1. (1) | l :— | — :— | — :— ‖
(2) | l :— :— | — :— :— ‖

2. Write the names of the following intervals :—(1) *fah* to *me*; (2) *soh* to *te*; (3) *fah* to *me*^{1}; (4) *fah* to *te*.

2. (1) Minor 2nd; (2) Major 3rd; (3) Major 7th; (4) Pluperfect 4th.

3. Write the following an octave higher, and state what is meant by the direction "Key G" :—

Key G.
| d :s | m :f | s :l | r :s | m :— ‖

3. Key G.
| d^{1} :s^{1} | m^{1} :f^{1} | s^{1} :l^{1} | r^{1} :s^{1} | m^{1} :— ‖

"Key G" means that after sounding C^{1} on the pitch-fork, we are to run down the scale to G, and take that as the *doh* of the tune, which is written in the "Key of G," as it is called.

SECOND YEAR.

Pupil Teachers at end of Second Year.

Three hours and a half allowed for this Paper.

MALES.

Euclid.

All generally understood abbreviations for *words* may be used.

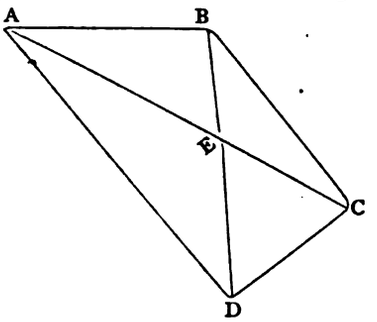
1. The angles at the base of an isosceles triangle are equal to each other; and if the equal sides be produced, the angles on the other side of the base shall be equal.

Prop. 5, Bk. I.

2. If two straight lines cut one another, the vertical, or opposite angles shall be equal.

Prop. 15, Bk. I.

3. The four sides of any quadrilateral are together greater than the two diagonals, and less than twice the two diagonals.



In the quadrilateral ABCD, AB, BC are greater than AC (I. 20); BC, CD greater than BD; CD, DA greater than AC; DA, AB greater than BD. That is, twice AB, BC, CD, DA are greater than twice AC, BD; or AB, BC, CD, DA are together greater than the two diagonals AC, BD.

Again, let the two diagonals cut one another in the point E, then (I. 20) DE, EC are greater than DC; CE, EB greater than BC; BE, EA greater than AB; and AE, ED greater than AD; or twice AC, BD are greater than the sides AB, BC, CD, DA; that is, the four sides of the quadrilateral are together less than the two diagonals. Q. E. D.

Arithmetic.

FEMALES.

1. Express $\frac{1}{8}$ of 2s. 6d. + $\frac{1}{3}$ of a guinea + $\frac{2}{5}$ of £1 − $\frac{1}{10}$ of penny as the fraction of £5.

	d.
$\frac{1}{8}$ of 2s. 6d.	$= 11\frac{1}{4}$
$\frac{1}{3}$ of a guinea	$= 201\frac{1}{3}$
$\frac{2}{5}$ of £1	$= 400$
	$612\frac{17}{60}$
deduct	$\frac{1}{10}$
	$612\frac{3}{4}$

$612\frac{3}{4}$d. to the fraction of £5 $= \frac{612\frac{3}{4}\text{d.}}{£5}$

$= \frac{2451 \text{ far.}}{4800 \text{ far.}} = \frac{817}{1600}$ of £5. Ans.

2. What fraction of $2\frac{1}{2}$ cwt., together with 3 qrs. 14 lbs., will give a ton and a half?

Fraction required $= \frac{1 \text{ ton } 10 \text{ cwt.} - 3 \text{ qrs. } 14 \text{ lbs.}}{2\frac{1}{2} \text{ cwt.}}$

$= \frac{30 \text{ cwt.} - 3\frac{1}{2} \text{ qrs.}}{2\frac{1}{2} \text{ cwt.}}$

$= \frac{29\frac{1}{2} \text{ cwt.}}{2\frac{1}{2} \text{ cwt.}} = \frac{118}{100}$. Ans.

3. Reduce to a decimal $\frac{7{\cdot}75}{9}$ of $\frac{2\frac{1}{2}}{2\frac{7}{8}}$ of $\frac{2\frac{2}{3}}{3\frac{1}{11}}$.

$\frac{7{\cdot}75}{9}$ of $\frac{2\frac{1}{2}}{2\frac{7}{8}}$ of $\frac{2\frac{2}{3}}{3\frac{1}{11}} = \frac{7\frac{3}{4}}{9} \times \frac{2\frac{1}{2}}{2\frac{7}{8}} \times \frac{2\frac{2}{3}}{3\frac{1}{11}}$

$= \frac{31}{36} \times \frac{44}{23} \times \frac{22}{31}$

$= \frac{1}{2} = {\cdot}5$. Ans.

4. What part of £9 is ½ of $\frac{5}{12}$ of half-a-crown?

$$\frac{\frac{1}{2}\text{ of }\frac{5}{12}\text{ of 2s. 6d.}}{£9} = \frac{2\frac{1}{2}\text{s.} \times 9 \times 1}{2 \times 10 \times 180\text{s.}} = \frac{5 \times 9 \times 1}{2 \times 2 \times 10 \times 180.} = \frac{1}{\underline{\underline{160}}}.$$ Ans.

Grammar.

MALES AND FEMALES.

'At the close of the day, when the hamlet is still,
And mortals the sweets of forgetfulness prove,
When nought but the torrent is heard on the hill,
And nought but the nightingale's song in the grove;
'Twas thus, by the cave of the mountain afar,
While his harp rang symphonious, a hermit began;
No more with himself or with nature at war,
He thought as a sage, though he felt as a man.'

BEATTIE.

1. Paraphrase the above extract.
2. Analyse the last four lines.
3. Parse the first and second lines.

1. 'In the evening, when the day's labours are over; when the village and its inhabitants are hushed in repose; when silent is everything, except the distant gush of the mountain stream, or the note of some night-bird in the woodland,'—In the above strain did the recluse, who passes his life apart from his fellow-creatures, begin to sing, while he accompanied his voice with the harp. He had reached that happy stage of his life when he is at peace with himself and all things, while at the same time sympathising with the failings of mankind.

ANALYSIS.

Sentences.	Kind.	Subject.	Predicate.	Extension.	Connective.
(1) 'Twas thus	Principal	it	was thus		
(2) By the cave of a mountain afar a hermit began,	Subord. noun to (1)	a hermit	began	by the cave of a mountain afar (*place*)	(that)
(3) While his harp rang symphonious.	Subord. adv. to (2)	his harp	rang	symphonious (*manner*)	while
(4) No more with himself or with nature at war, he thought	Principal	he no more . . . at war	thought	sent. (5) (*manner*)	
(5) as a sage (thinks),	Subord. adv. to (4)	a sage	(thinks)		as
(6) though he felt	Subord. adv. to (4)	he	felt	sent. (7) (*manner*)	though
(7) as a man (feels).	Subord. adv. to (6)	a man	(feels)		as

PARSING.

at—prep., gov. obj. case 'close.'
the—def. art. or dist. adj. defining 'close.'
close—abstr. noun, neut., sing., obj., gov. by 'at.'
of—prep. showing relation between 'close' and 'day.'
the—same as above, defining 'day.'
day—abstr. noun, neut., sing., obj. gov. by 'of.'
when—subord. temporal conj., introd. subord. adv. sent.
the—as above, defining 'hamlet.'
hamlet—com. noun, neut., sing., nom., subj. of 'is.'
is—irreg. intrans. verb, *am*, *was*, *been*, indic., pres., indef., 3rd pers. sing. agr. with 'hamlet.'
still—predic. adj. qual. 'hamlet.'
and—copulative conj. connecting two subord. sentences.
mortals—com. noun, mas., plur., nom., subj. of 'prove.'
the—as above, defining 'sweets.'
sweets—abstr. noun, neut., plur., obj. gov. by 'prove.'
of—prep. showing the relation between 'sweets' and 'forgetfulness.'
forgetfulness—abstr. noun, neut., sing., obj. gov. by 'of.'
prove—reg. trans. verb, indic. pres. indef., 3rd pers. plur. agr. with 'mortals.'

4. Make three sentences each containing a relative pronoun in the objective case.

1. This is a passage *which* I have seen before.
2. He is a person *whom* I have met often.
3. There is the man *that* I gave the letter to.

5. In these words, Receiver, Recipient, Receptive, Reception, and Receivable, point out the use of the final syllable, and the effect it has on the meaning of the word.

FINAL SYLLABLE.	EFFECT.	USE.
—er	means an actor	forms nouns
—ent	,, ,,	,, ,,
—ive	,, 'inclined' to	,, adjectives
—tion	,, state or condition	,, abstract nouns
—able	,, able to be	,, adjectives

Geography.

Answer Two Questions.

1. **Draw a map showing** the course of a vessel, keeping close **to the** coast, from the mouth of the Loire to the mouth of the Vistula. Mark islands, seaports, straits, and river mouths.
N.B.—Insert the lines of latitude and longitude.

2. Give a short account of the differences of climate in the different parts of Great Britain and Ireland; and give reasons for these differences.

As all parts of the British Isles are bathed in the same sea-winds, so all share alike in the advantages they bring; and there is scarcely any difference between the winter climate of the southern coast of Britain and that of the Shetlands in the far north. The prevailing wind is from the west, and this wind, laden with the moist vapours of the ocean which it has traversed, first breaks upon Ireland; and hence the climate of this island is damper than that of the rest of the British group. As the western mountain chains of Ireland are comparatively low, the rainclouds are not effectually caught by them, and so distribute their moisture more evenly over the whole surface of the country than in the island of Great Britain. In Britain, on the other hand, the mountains of the west are high enough to intercept a large proportion of the moisture borne along by this wind, and thus a belt of rainy country extends along Western Britain. The rainfall on the eastern plains is, however, very considerable, and thus this abundant supply of moisture, co-operating with a moderate climate, promotes the fertility of the British Islands.

3. Describe fully the physical and political features of the basin of the Indus.

The basin of the Indus is very fertile, but wants cultivation. The best portion is that near the Himalaya range, which is the most favourable district in India for the growth of corn. The Indus and its four tributaries give name to 'the Punjab,' the greater part of which is naturally divided into Doabs formed by the rivers by which it is intersected. This country is very fertile when cultivated, and produces rice, cotton, indigo, tobacco, hemp, etc. Since 1859 much has been done for the Punjab by the construction of roads, canals, railways, etc., to develop its resources. The chief towns in its basin are Cabool, Peshawur, Lahore, Umritsir, Mooltan, Aliwal, Hyderabad, Tattah, and Kurrachee. Sinde, a division of the Bombay Presidency, lies in the lower valley and delta of the Indus. This river, like the Ganges, is subject to annual floods; and as the banks are low, the country is frequently widely inundated, when sometimes villages and even towns are washed away.

Needlework.

Two hours and a half allowed.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination papers.

Arithmetic.

MALES.

1. If a man invests £4065 in 4½ per cent. debentures at 135½, what dividend will he get, the usual brokerage being charged?

£4½ is got from 135½ + ½ or 135½
∴ £135½ : £4065 :: £4½ : dividend.

$$\frac{£4\frac{1}{2} \times 4065}{135\frac{1}{2}} = \frac{£9 \times 4065}{271} = \underline{\underline{£135}}.$$ Ans.

2. In what time will £960 12s. 6d. amount to £1052 16s. 10½d. at 4 per cent. per annum, simple interest?

Interest = (£1052 16s. 10½d. − £960 12s. 6d.) = £92 4s. 4½d.

£4	:	£92 4s. 4½d.
20		20
80		1844
12		12
960		22132
5		5
4800		110664

£960½ : £100 :: 1 yr. : time

$$\frac{1 \text{ yr.} \times 110664 \times 100}{4800 \times 960\frac{1}{2}} = \frac{110664 \times 8}{48 \times 7685} \text{ yrs.}$$

$$= \frac{885312}{368880} \text{ yrs.}$$

$$= 2\tfrac{136}{368} = 2\tfrac{17}{46} \text{ yrs.}$$ Ans.

3. A farmer buys 25 sheep at £2 5s. each, and 15 at £2 2s. each; he keeps them for a month at a cost of 5s. each, and sells them all at £2 15s. 6d. each. What is his average gain per sheep?

	£	£ s.
25 sheep at	2¼ =	56 5
15 „ „	2 1/20 =	31 10
		87 15
40 „ „	¼ =	10 0
Total cost	=	97 15
40 sheep sold at £2 15s. 6d. ea.	=	111 0
Gain on 40 sheep	=	13 5
„ ea. „	=	6 7½d. Ans.

4. A man divided his property amongst his three sons in the proportion of ⅘, 7/20, and ⅖. What percentage of the property did they respectively get? (Correct to two decimal places.)

$$\tfrac{4}{5} + \tfrac{7}{20} + \tfrac{2}{5} = \frac{72+50+45}{120} = 167 \text{ shares.}$$

167 : { 72, 50, 45 } :: 100 { 43·11 p.c. of 1st. Ans. ; 29·94 „ 2nd. Ans. ; 26·94 „ 3rd. Ans.

History.

MALES AND FEMALES.

1. What measures of improvement make the reign of Henry II. memorable? What sorrows and reverses attended his death?

As soon as Henry II. was crowned, he set himself in good earnest to reform the country. He speedily reduced the turbulent nobility to some degree of submission; and at the great council of the nation, held at Clarendon, he procured the passing of laws or constitutions which brought the clergy under his control, and deprived the pope of his chief advantage for troubling England. He thought to have got Becket to side with him in these reforms, but this churchman turned against him. The murder of Becket brought humiliation upon Henry, and he suffered penance and flagellation at his tomb. Various circumstances in Wales, France, and Ireland gave Henry an opportunity of extending his dominions, so that he became the most powerful monarch in Europe. But now he was doomed to domestic trials; his sons rebelled, and joined with the French king and his own nobility in taking up arms against him. His own queen aided them; repeated treaties were made and broken; and at last the unhappy king saw his youngest and favourite son John forsake him, and, brokenhearted, he died 1189.

2. Who was Simon de Montfort? Are we under any obligations to him?

Simon de Montfort, Earl of Leicester, was the leader of the rebellious barons in their attacks on Henry III., which led to the victory of Lewes. He subsequently summoned the representatives of the freeholders and burgesses in such a way as to lay the foundation for the existence and the authority of our House of Commons. He fell in the same year, 1265, in battle at Evesham, when Prince Edward was conqueror, and Henry III. was delivered from captivity.

2. How did Henry VII. come to the throne? Sketch his reign, and suggest a reason why among the historical plays of our great poet none relate to this period.

Henry VII., the first monarch of the Tudor dynasty, the overthrower and successor of Richard III., was descended from John of Gaunt on his mother's side, and from the widowed queen of Henry V. on his father's; and thus embodied all the claims of the House of Lancaster. He was an exile in France when the Duke of Buckingham invited him to join in a rising against the usurper Richard III. Buckingham rose before Henry reached England, and was defeated, captured, and executed. Henry landed in Wales, met Richard at Bosworth, gained the victory, and his opponent was slain. In order to strengthen his title to the throne, he, after some delay, married Elizabeth, the eldest daughter of Edward IV., thus bringing to an end the disastrous rivalry of the Houses of York and Lancaster. But he was not allowed to retain his throne wholly in peace. After a feeble effort by an English nobleman, the Duchess of Burgundy, sister of Edward IV., obtained one Lambert Simnel to personate a brother of Richard III. He was defeated in a decisive battle and made a turnspit. Six years after appeared another claimant to the throne, claiming to be the young Duke of York who was said to have been murdered in the Tower. He received support from all the Yorkists, and from the Scottish king, but he also was unsuccessful, and was afterwards executed along with that Earl of Warwick whom Simnel pretended to be. A pretended war with France, and the marriage of the Princess Margaret Tudor to James IV., King of Scotland, from which marriage sprang the unhappy race of Stuarts, are the only other events of importance.

Lord Bacon wrote a fine history of this king to please James I., but Shakespear may have thought him not worthy of a play, or perhaps he did not think it wise to meddle with the founder of the Tudor dynasty while living under his great descendants, Elizabeth and James.

Teaching.

What are the advantages of ruling the slates of very young children in triple lines for teaching writing? Give a specimen of a copy so set as to show the use of the three lines.

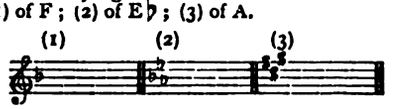
The great advantages of ruling the slates with three lines are, showing where (1) some of the letters are to be begun, (2) how high they are to go, and (3) how far down they are to go. For example, *o* begins on the middle line, proceeds to the top line, exactly touches it, curves down to the bottom line, exactly touches it, and joins the first part of the letter on the middle line. In making *n* we commence on the middle line, make a curve to the right exactly touching the top line, and bring the downstroke to the bottom line, thus making the first part of the letter *n*. The second part of the *n* commences on the middle line, goes up to the top line, makes a bold curve touching the top line, comes as a downstroke and forms another curve touching the bottom line, and finishes on the middle line. The capitals may be taught by means of the three lines in a similar way.

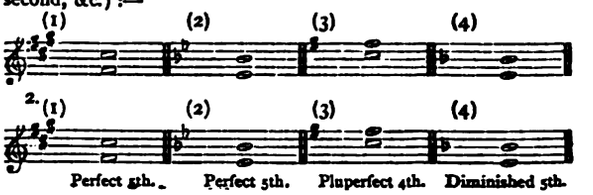
Music.

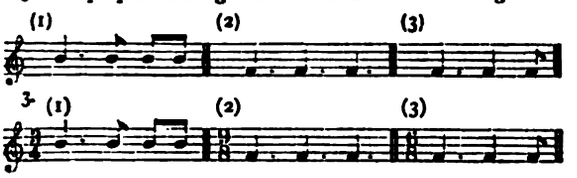
A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write the key-signatures of each of the following major keys:—(1) of F; (2) of E♭; (3) of A.



2. Write below each of the following intervals its name (major second, &c.):—

Perfect 5th. Perfect 5th. Imperfect 4th. Diminished 5th.

3. Add proper time-signatures to each of the following :—

TONIC SOL-FA NOTATION.

1. Write the names of the following intervals :—(1) *lah* to *me* ; (2) *doh* to *fah* ; (3) *te* to *fah* ; (4) *fah* to *te*.

1. (1) Perfect 4th ; (2) Perfect 5th ; (3) Pluperfect 4th ; (4) Diminished 5th.

2. What is the mental effect (1) of *fah* ? (2) of *me* ? (3) of *lah* ?

2. (1) Awe-inspiring ; (2) calm and peaceful ; (3) mournful.

3. What are the five kinds of measure most commonly used ?

3. Two-pulse ; three-pulse ; four-pulse ; six-pulse ; and nine-pulse.

THIRD YEAR.

Pupil Teachers at end of Third Year, *if apprenticed on or after 1st May,* 1878 ; **and Pupil Teachers at end of Fourth Year,** *if apprenticed before that date.*

Three hours and a half allowed.

Euclid.

[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including Question 3, *if you can.*

MALES.

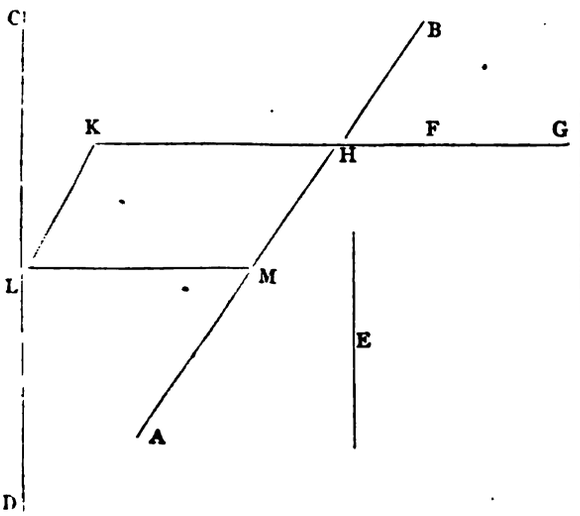
1. If a side of any triangle be produced, the exterior angle is equal to the two interior and opposite angles ; and the three interior angles of every triangle are together equal to two right angles.

Prop. 32, Bk. I.

2. The complements of the parallelograms which are about the diameter of any parallelogram are equal to one another.

Prop. 43, Bk. I.

3. Between two given straight lines it is required to draw a straight line which shall be equal to one straight line and parallel to another.



Let AB, CD be the two given straight lines ; it is required to draw a straight line between AB and CD equal to E, and parallel to FG.

Produce GF to K, meeting AB in H, and make HK = E.
Through K draw KL, meeting CD in L.
Through L draw LM parallel to KH (that is FG), meeting AB in M.
LM is the straight line required.
By construction the figure KHML is a parallelogram, and (I. 34) its opposite sides are equal. ∴ LM = KH, and KH was made equal to E. ∴ LM = E, and LM is drawn parallel to FG between AB and CD. Wherefore LM is the straight line required. Q. E. F.
N.B.—H may be taken anywhere in either line, and HK drawn parallel to FG and equal to E, with same result.

Algebra.

Answer two Questions.

1. Divide the product of $a+b-c$, $a-b+c$, and $b+c-a$ by $a^2-b^2-c^2+2bc$.

$$\frac{(a+b-c)(a-b+c)(b+c-a)}{(a^2-b^2-c^2+2bc)} = \frac{\{a+(b-c)\}\{a-(b-c)\}(b+c-a)}{(a^2-b^2-c^2+2bc)}$$
$$= \frac{a^2-(b-c)^2(b+c-a)}{(a^2-b^2-c^2+2bc)}$$
$$= \frac{(a^2-b^2-c^2+2bc)(b+c-a)}{(a^2-b^2-c^2+2bc)}$$
$$= \underline{b+c-a}. \text{ Ans.}$$

2. Find the L C.M. of $x^3-9x^2+26x-24$, $x^3-10x^2+31x-30$, and $x^3-11x^2+38x-40$.

($x-2$ is a factor of each expression)

$x^3-9x^2+26x-24=(x-2)(x^2-7x+12)=(x-2)(x-4)(x-3)$
$x^3-10x^2+31x-30=(x-2)(x^2-8x+15)=(x-2)(x-3)(x-5)$
$x^3-11x^2+38x-40=(x-2)(x^2-9x+20)=(x-2)(x-4)(x-5)$
∴ L. M. C. $=\underline{(x-2)(x-3)(x-4)(x-5)}$. Ans.

3. Find two consecutive numbers, the difference of their squares being 57.

Let x = the one number.
Then $x+1$ = the other
$\therefore (x+1)^2-x^2=57$
$x^2+2x+1-x^2=57$
$2x=57-1$
$2x=56$
$x=\underline{28}$

Hence the numbers are 28 and 29. Ans.

Mensuration.

Find the rent of a triangular field whose sides are $7\frac{1}{2}$, $8\frac{1}{2}$, and $10\frac{3}{4}$ chains at 45s. per acre.

$\frac{1}{2}$ sum of sides $= 13\frac{1}{4}$ chains.

$$\therefore \text{area of } \Delta = \sqrt{13\tfrac{1}{4}\times 5\tfrac{3}{4}\times 5\times 2\tfrac{1}{2}}$$
$$= \sqrt{\tfrac{53}{4}\times\tfrac{23}{4}\times 5\times\tfrac{5}{2}}$$
$$= \sqrt{\tfrac{30475}{32}}$$
$$= \sqrt{952{\cdot}34375}$$
$$= 30{\cdot}86 \text{ sq. chains}$$
$$= 3{\cdot}086 \text{ ac.}$$

3·086 ac. at £2½ each = £6·943 = £6 18s. 10½d. nearly. Ans.

Arithmetic.

FEMALES.

1. Express $\frac{3}{4}$ of half-a crown + $\frac{1}{8}$ of a shilling as a decimal of 7s. (to 4 places of decimals).

	s.
$\frac{3}{4}$ of 2s. 6d. = $\frac{3}{4}$ of 2·5s.	= ·9375
$\frac{1}{8}$ of 1s.	= ·8
	= 1·7375s.

and 1·7375s. to the dec. of 7s. $= \frac{1{\cdot}7375}{7}$

$= \underline{{\cdot}2482\ldots}$s. Ans.

2. Find the value of ·75 of 6s. 8d. − 1·84375 of 4s. + 3·9796 of 2s.

	s.
·75 of 6s. 8d. = $6\frac{2}{3} \times \cdot 75$ =	5·0000
+ 3·9796 of 2s. =	7·9593
Sum =	12·9593
− 1·84375 of 4s. =	7·375
Remainder =	5·5843s.
	12
	7·012d.

∴ The value = 5s. 7·012d. Ans.

3. A owned $\frac{4}{17}$ of a vessel and sold $\frac{3}{11}$ of $\frac{2}{3}$ of his share for £$\frac{400}{33}$; what was the value of $\frac{1\frac{2}{3}}{4\frac{1}{2}}$ of $\frac{2}{3}$ of the vessel?

(*a*) $\frac{3}{11}$ of $\frac{2}{3}$ of $\frac{4}{17} = \frac{3 \times 2 \times 4}{11 \times 9 \times 17} = \frac{8}{561}$

(*b*) $\frac{1\frac{2}{3}}{4\frac{1}{2}}$ of $\frac{2}{3} = \frac{\frac{10}{3}}{\frac{17}{2}}$ of $\frac{2}{3} = \frac{40 \times 2}{136 \times 5} = \frac{4}{17}$

∴ $\frac{8}{561} : \frac{4}{17} :: £\frac{400}{33} : ?$

$£\frac{400 \times 2 \times 561}{33 \times 17 \times 8} = £100.$ Ans.

4. If the fourpenny loaf weigh 3·35 lbs. when wheat is at 4·75s. a bushel, what ought to be paid for 47½ lbs. of bread when wheat is at 13·4s. a bushel?

After reducing the decimals to vulgar fractions, the following is the statement:—

$$\left.\begin{matrix} 3\frac{7}{20} \text{ lbs.} : 47\frac{1}{2} \text{ lbs.} \\ 4\frac{3}{4}\text{s.} : 13\frac{2}{5}\text{s.} \end{matrix}\right\} :: 4\text{d.} : ?$$

$$\frac{4\text{d.} \times 95 \times 67 \times 4 \times 20}{2 \times 5 \times 19 \times 67} = 160\text{d.} = 13\text{s. } 4\text{d.}$$ Ans.

Grammar.

MALES AND FEMALES.

1. 'Lie not; but let thy heart *be true* to God,
Thy mouth to it, thy actions *to them both;*
Cowards tell lies, and *those that fear* the rod,
The stormy working soul vents lies and froth.
Dare to be true, nothing can need a lie;
A fault which needs it most *grows two thereby.*'

GEORGE HERBERT.

Paraphrase this extract.

2. Parse the words printed in italics.

3. Analyse the last four lines.

1. Tell the truth; let your words give expression to the thoughts that are known to God, and let your deeds correspond with what you think and what you say. Lying is unknown to brave men; it is a quality only of those who fear punishment. Blustering and boasting spirits alone give mouth to false vaunting and high-sounding phrases. Have the courage to speak the truth; it is better to own faults than increase them by shielding one's self with a lie. There is no excuse for using deceit.

PARSING.

Be—intrans. irreg. verb, *am, was, been*, infin. pres. indef., gov. by 'let.'
true—predic. adj., qual. 'heart.'
to—prep., showing relation between 'true' and 'them.'
them—demonst. pron., 3rd pers., plur., referring to 'heart' and 'mouth,' obj., gov. by 'to.'
both—predic. adj, qual. 'them.'
those—demonst. adj. pron., mas. or fem., plur., nom., subj. of (*tell*).
that—simple rel. pron., mas. or fem., plur., referring to 'those,' nom., subj. of 'fear.'
fear—reg. trans. verb, indic., pres. indef., 3rd pers., plur., agr. with 'that.'
grows—irreg. intrans. verb, *grow, grew, grown*, indic. pres. indef., 3rd pers., sing., agr. with 'fault.'
two—numeral adj., qual. (faults) nom. after 'grows.'
thereby—adv., mod. 'grows.'

ANALYSIS.

Sentence.	Kind.	Subj.	Predicate	Object.	Extension.	Connective.
(1) Cowards tell lies	Principal	Cowards	tell	lies	...	...
(2) and those (tell lies)	Principal.	those	(tell)	(lies)	...	and
(3) that fear the rod	Subord. adj. to (2)	that	fear	the rod	...	that
(4) The stormy working soul vents lies and froth	Principal.	the stormy working soul	vents	lies and froth	...	...
(5) Dare to be true	Principal.	(you)	dare	to be true (*completion*)	...	...
(6) Nothing can need a lie	Principal.	Nothing	can need	a lie	...	...
(7) A fault grows two thereby	Principal.	a fault	grows	two (*completion*)	thereby (*manner*)	...
(8) which needs it most.	Subord. adj. to (7)	which	needs	it	most (*degree*)	whic

4. Correct, if needful, these sentences, and give your reasons for altering them:—

'Let thou and I the battle try.'
'There let him lay.'
'My banks they are furnished with bees.'
'This England never did, nor never shall
Lie at the proud foot of a conqueror.'

'Let *thee* and *me* the battle try.'—Transitive verbs govern the objective case.

'There let him *lie*.'—*Lay* is transitive, and the meaning requires it intransive.

'My banks are furnished with bees.'—Unless when very particular emphasis is necessary, a noun and its pronoun should not be used as the nominative to the same verb. Poets use both frequently.

'This England never did, and never shall
Lie at the proud foot of a conqueror.'—Two negatives coming together in English make an affirmation. The meaning here requires a negative.

5. Make a list of noun terminations, by which you may know that certain words are Latin and not English in their origin. Give three examples of each formation.

LATIN TERMINATIONS.	EXAMPLES.
—or	inspector, confessor, doctor.
—ent	respondent, superintendent, agent.
—ary	lapidary, plenipotentiary, aviary.
—ant	descendant, occupant, pendant.
—ate	advocate, confederate, estimate.
—acy	accuracy, celibacy, privacy.
—ance—ancy	fragrance, constancy, variance.
—ion	creation, union, tension.
—tude	multitude, gratitude, magnitude.
—ure	rapture, conjecture, scripture.

Geography.

(*Answer either Q. 2 or Q. 3; not both, unless you do the map in Q. 2.*)

1. Draw a full map, showing Burmah, Siam, and the islands of the Indian Archipelago.

N.B.—Insert the lines of latitude and longitude.

2. What are the *tropics?* What parts of Asia and Africa lie between the tropics? Explain, *as to children*, why these countries have so hot a climate.

If you like, instead of the map in Q. 1, you may draw a sketch-map in illustration of this answer.

At a point 23½° north of the equator (at the tropic of Cancer), the vertical sun appears to stop when it is mid-summer with us. As it moves southward our summer wanes; it crosses the equator and appears to travel on until it has reached 23½° on the other side of the line (the tropic of Capricorn); then six months have passed—it is mid-winter with us and mid-summer with the people in the southern hemisphere. The sun turns back (the word *tropic* meaning the place of turning), retraces its course over the equator, and at the expiration of a twelvemonth is at our tropic (Cancer) again, bringing us summer.

In Asia the southern halves of Arabia and Hindostan, nearly the whole of Further India with a small part of China, and the whole of the East India Islands lie within the tropics. The whole of Africa, with the exception of Morocco, Algeria, Tunis, Tripoli, Egypt, the northern third of the Sahara, Cape Colony, Natal, the Transvaal and Namaqua Land, lies within the tropics.

The reason that it is hotter in those parts of the world arises from the fact of its being within the Torrid Zone, where the sun is vertical at noon over every place two days in the year. The more nearly the sun approaches the zenith of an observer the more powerful is the heat.

3. Explain, *as to children*, the nature of land and sea breezes.

LAND AND SEA BREEZES.

DEFINITION.—Land breezes blow from the land to the sea. Sea breezes blow from the sea towards the land. (*Illustrate from the draught of air from the room up the chimney, also from the currents of colder air from the outside into the room under the door; and that of the warmer air over the door.*)

CAUSE.—If the sun shines on two tracts of surface, the one water and the other solid land, the latter becomes more rapidly heated than the former, and at the end of the day will be found much warmer than the water. On the other hand, in the absence of the sun the land cools faster than the water, and at the end of the night it will be found below the temperature of the adjoining water. When the land is hottest, the air resting upon it will be hotter and lighter than the air over the sea, and the cold air from the sea will rush in upon the hot. (*Compare these effects with the hot air in the room (or over the fire), going through the chink at the top of the door (or up the flue), and the cold current coming in under the door and towards the fire.*) Thus during the day there will be a breeze from the sea to the land, and during the night a breeze from the land to the sea. These sea and land breezes are felt regularly on all sea-coasts when the other winds are not too strong.

Needlework.

Two hours and a half allowed.

FEMALES.

(The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination papers.)

SECOND PAPER.

Two hours and a half allowed.

Arithmetic.

MALES.

1. If a man sells £4,000 stock from the 3 per cents. at par, and with the proceeds buys 6 per cent. railway debentures at 160; what is the difference in his income? (Omit brokerage.)

Income from 2nd investment $= \frac{£4000 \times 6}{160} = £150$

,, ,, 1st ,, $= \frac{£4000 \times 3}{100} = £120$

Increase of income = £30. Ans.

2. Find the compound interest on £750 for 3½ years at 4 per cent. per annum.

	£
For 1st yr. £4 gives $\frac{1}{25}$ of princ.	750
	30
,, 2nd ,, ,, ,, $\frac{1}{25}$,,	780
	31·2
,, 3rd ,, ,, ,, $\frac{1}{25}$,,	811·2
	32·448
,, ½ yr. ,, ,, $\frac{1}{50}$,,	843·648
	16·87296
	860·52096
	750
	110·52096
	20
	10·4192 s.
	12
	5·0304

Compound int. = £110 10s. $5\frac{1}{25}$d. Ans.

3. Find the square roots of 361·732 and $37\frac{1}{144}$, the former to 4 decimal places.

(a)

361·732 (19 0192. Ans.
1
29 | 261
261
3801 | 7320
3801
38029 | 351900
342261
380382 | 962900
760764

(b)

$37\frac{1}{144} = \frac{37 \times 144 + 1}{144} = \frac{5329}{144}$

(c)

$\sqrt{\frac{5329}{144}} = \frac{73}{12} = 6\frac{1}{12}$. Ans.

4. A dealer by selling 72 sheep for £153 18s. lost 5 per cent.; what would he have gained per cent. and per sheep if he had sold them for £178 4s.?

(a)

£153 18s. or 3078 s. : £178 4s. or 3564 s. :: 95 : Hundredths of price.

$\frac{95 \times 3564}{3078} = \frac{95 \times 396}{342} = \frac{95 \times 22}{19} = 110$

Now 110 hundredths give a gain of 10 p. c. Ans.

(b)

	£	s.	d.
$\frac{£178\ 4s.}{72}$	2	9	6
$\frac{£153\ 18s.}{72}$	2	2	9
Gain per sheep =	0	6	9. Ans.

History.

MALES AND FEMALES.

1. What was the Commonwealth? How did it begin and end?

Soon after the execution of Charles I., the members of the 'Rump' Parliament voted the abolition of the monarchy and of the House of Lords. The new constitution was in outward form a republic, or, as they called it, 'a Commonwealth and Free State' under the supreme authority of the representatives of the people in Parliament. The practical business of Government was placed in the hands of forty-one members selected from the House of Commons, and called a Council of State. Some voices declared that the new Government was no better than the old, and in the army these mal-contents—called 'Levellers'—broke out into a mutiny which was swiftly crushed by Cromwell. Scotland and Ireland were in favour of a monarchy under Prince Charles, but Cromwell soon reduced these to obedience, and decisively defeated Charles at Worcester, 1651.

After the dissolution of Parliament by Cromwell, 1654, his Protectorate became a tyranny, but with more public aims than that of Charles I. Cromwell's third Parliament offered to make him king, but he refused to accept the crown. A few months afterwards Cromwell died and was succeeded in the Protectorate by his son Richard, who was so helpless that he had to resign. Anarchy now threatened the nation, when General Monk marched to London, and secured the calling of a free Parliament, which recalled King Charles II., 1660.

2. Who was the wife of George II.? Describe her character and political influence.

The wife of George II. was Caroline of Anspach. She was a very bright, clever, good-tempered woman. She governed her husband without letting him know of it, and she was guided by the great minister Sir Robert Walpole, whose constant policy was to keep England at peace, and himself in power. Between the Queen and the minister the reign was one of peace and prosperity.

3. In what wars has this country been engaged since 1850? Mention briefly their results.

The *Crimean War*, 1854-56, resulted in the defeat of the Russians; the strong fortress of Sebastopol being taken by the combined French and English armies, after a long and severe struggle. Peace was made by the Treaty of Paris, 1856.

In the year 1857, a mutiny broke out among the native troops of India, and spread over the whole country. It was put down by Sir Colin Campbell, 1858, and the result of the whole contest was that the Government of India was transferred from the East India Company to the hands of the Queen of England.

The Abyssinian war, 1867-8, was conducted by Sir Robert Napier (Lord Napier of Magdala), to free some British, imprisoned by King Theodore. The Abyssinians retired on the approach of the English troops, and the prisoners were sent into the British Camp. The loss of the British in the war was only twenty wounded, of whom two died. King Theodore committed suicide.

In 1874 the Ashantees interfered with the commerce of tribes under British protection, but Sir Garnet Wolseley compelled the king to accept terms of peace, after the destruction of his capital, Coomassie.

In 1878 a war began with the Afghans, and, after various events, was finished in 1880 by Sir Fred. Roberts, who placed a king favourable to the British on the throne.

The Zulu war, 1878-79, was ended by the complete defeat of Cetewayo at Ulundi; Cetewayo was captured and imprisoned.

In 1882 a massacre of Europeans at Alexandria and other causes led to the Egyptian war, in which the rebel Arabi was defeated at Tel-el-Kebir. Arabi was captured and afterwards banished to Ceylon.

Events are occurring in Egypt at this present moment (February, 1884), which may lead to the active intervention of a British force.

Teaching.

Sketch out the notes of a lesson suited for a junior class, on *the divisions of time.*

OBJECTS TO BE SEEN:—*Terrestrial Globe—Clock—Watch—Hour-glass—Sun-dial*—or *pictures of these.*

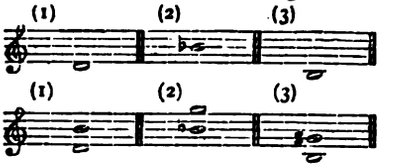
Introduce subject by questioning the class about what time is given for work—what for rest—eliciting *day* and *night*—show that the common time-keeper is the *sun*—but not exact enough. What contrivances have been made for showing divisions of time? Show hour-glass, or common three-minute glass in use—refer to sun-dial and explain the principle of it—show the use of a clock, and that it is necessary to have a striking apparatus attached, to warn us of the flight of time—show how deceiving it is to guess the time. Revolution of earth in 24 hours—making a day—day=24 hours from midnight to midnight—hour=60 minutes—minute=60 seconds. Seven revolutions a week—365 a year=earth's journey round the sun. (Cause the globe to revolve in their presence.) Explain month by reference to the moon—ask meanings of morning—forenoon—noon—explain a.m. by the sun coming to the meridian—afternoon—p.m.—evening—night—ask for names of days of the week—months of the year—seasons—and quarterly terms.

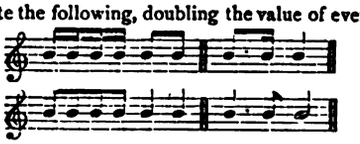
Note.—Names to be written on B.B., and spelt and pronounced by the class.

Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write major sixths above the following notes:—

2. Re-write the following, doubling the value of every note:—



3. State (briefly) the meanings of the following:—(1) M. 100; (2) *Dal Segno*; (3) *Staccato.*

3. (1) "M. 100" means that the pendulum of the Metronome is to make 100 vibrations per minute; (2) *Dal Segno* means repeat from the sign 𝄋; (3) *Staccato* means that each note is to be sung or played separately and distinctly.

TONIC SOL-FA NOTATION.

1. Write major sixths above the following notes:—(1) *ray*; (2) *ta*; (3) *te*$_1$.

1. (1) *Ray* to *te*; (2) *ta* to *soh*^{1}; (3) *te*$_1$ to *se.*

2. Re-write the following in four-pulse measure, doubling the value of each note:—

2. |s ,l .s ,f :m .f |s .,f :m ‖

2. |s .l :s .f |m :f |s :-.f |m :— ‖

3. State (briefly) the meanings of the following:—(1) M. 100; (2) *Dal Segno*; (3) *Staccato.*

3 (1) "M. 100" means that the pulses of the tune are to move at the rate of 100 in the minute; (2) repeat from the sign 𝄋; (3) each note is to be played or sung separately and distinctly.

FOURTH YEAR.

Pupil Teachers at end of Fourth Year, ***if apprenticed on, or after,*** **1st *May*, 1878; and Pupil Teachers at end of Fifth Year,** ***if apprenticed before that date.***

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including Question 3, *if you can.*

1. If there be two straight lines, one of which is divided into any number of parts, the rectangle contained by the two straight lines is equal to the rectangles contained by the undivided line, and the several parts of the divided line.

Prop. 1, Bk. II.

2. If a straight line be divided into two equal, and also into two unequal parts, the squares on the two unequal parts are together double of the square on half the line and of the square on the line between the points of section.

Prop. 9, Bk. II.

3. Divide a given straight line into two parts such that the sum of their squares may be the least possible.

If a straight line be bisected, *the sum of the squares on the two halves is the least possible;* for if the line be cut in any other point the line will be cut unequally, and by Prop. 9, Bk. II., the sum of the squares on the two unequal parts is double of the square on half the line and of the square on the line between the points of section; or, in other words, the sum of the squares on the parts of a line cut unequally is always greater than the sum of the squares on the halves of the line by double the square on the part between the middle of the line and the other point.

Algebra.

Answer two Questions.

1. Simplify $\frac{(a^2+b^2)^2}{ab(a-b)^2}-\frac{a}{b}-\frac{b}{a}-2$.

$$\frac{(a^2+b^2)^2}{ab(a-b)^2}-\frac{a}{b}-\frac{b}{a}-2$$
$$=\frac{(a^2+b^2)^2}{ab(a-b)^2}-\frac{a^2-b^2-2ab}{ab}$$
$$=\frac{(a^2+b^2)^2-(a+b)^2(a-b)^2}{ab(a-b)^2}$$
$$=\frac{(a^2+b^2)^2-(a^2-b^2)^2}{ab(a-b)^2}$$
$$=\frac{4a^2b^2}{ab(a-b)^2}=\underline{\frac{4ab}{(a-b)^2}}. \text{ Ans.}$$

2. Solve the equations :—

$$(1)\quad \begin{cases} \frac{3x}{10}-\frac{y}{15}-\frac{4}{9}=\frac{x}{12}-\frac{y}{18} \\ 2x-\frac{8}{3}=\frac{x}{12}-\frac{y}{15}+\frac{11}{10} \end{cases}$$

$$(1)\ (a)\quad \frac{3x}{10}-\frac{y}{15}-\frac{4}{9}=\frac{x}{12}-\frac{y}{18}$$
$$54x-12y-80=15x-10y$$
$$39x-2y=80$$

$$(b)\quad 2x-\frac{8}{3}=\frac{x}{12}-\frac{y}{15}+\frac{11}{10}$$
$$120x-160=5x-4y+66$$
$$115x+4y=226$$

From (a) $78x-4y=160$

$$193x=386$$
$$x=\underline{2}. \text{ Ans.}$$

Hence $y=\underline{1}$. Ans.

(2) $780x^2-73x+1=0$

$$780x^2-73x=-1$$
$$x^2-\tfrac{73}{780}x=-\tfrac{1}{780}$$
$$x^2-\tfrac{73}{780}x+(\tfrac{73}{1560})^2=(\tfrac{73}{1560})^2-\tfrac{1}{780}=\frac{5329-3120}{(1560)^2}$$
$$x^2-\tfrac{73}{780}x+(\tfrac{73}{1560})^2=\frac{2209}{(1560)^2}$$
$$x-\tfrac{73}{1560}=\pm\tfrac{47}{1560}$$
$$x=\tfrac{73}{1560}\pm\tfrac{47}{1560}$$
$$=\tfrac{120}{1560} \text{ or } \tfrac{26}{1560}=\underline{\tfrac{1}{13}} \text{ or } \underline{\tfrac{1}{60}}. \text{ Ans.}$$

3. A pound of tea and three pounds of sugar cost six shillings, but if sugar were to rise 50 per cent. and tea 10 per cent. they would cost seven shillings. Find the price of tea and sugar.

Let x = price of 1 lb. tea and y = price of sugar,

then $x+3y=6$s., or $11x+33y=66$s.,

and $\frac{11}{10}x+\frac{3}{2}y=7$s., or $\underline{11x+45y=70}$s.

$$12y=4\text{s.}$$

Sugar = $y=\underline{4}$d. Ans.

∴ Tea = $x=\underline{5}$s. Ans.

Mensuration.

A square of very thin gold whose side is 196 inches is divided into squares (like a chess board) each of whose sides is 14 inches, and circles incribed in these squares are punched out of them. If the price of gold leaf is £2 14s. per sq. yd., find the value of the remainder of the large square after the circles have been removed.

Area of square = 196×196 = 38416 sq. in.

,, circles = $14^2\times\cdot7854\times196$ = 30171·9264 sq. in.

area to be gilt = 8244·0736 sq. in.

area ,, in sq. yds. = 6·3612 nearly

6·3612 sq. yd. at £2 14s. per yd. = £17·17524

= £17 3s. 6d. nearly.

Arithmetic.

FEMALES.

1. At what rate per cent. will £325 16s. 8d. amount to £374 6s. $0\frac{1}{4}$d. in $3\frac{1}{2}$ years at simple interest?

Interest = £374 6s. $0\frac{1}{4}$d. − £325 16s. 8d. = £48 9s. $4\frac{1}{4}$d.

$$\left.\begin{matrix} 3\frac{1}{2} \text{ yrs.} \\ 325\frac{5}{8} \end{matrix}\right\} : 1 \text{ yr.} : 100 \;::\; £48\ 9\text{s.}\ 4\tfrac{1}{4}\text{d.} : ?$$

$$\frac{£48\ 9\text{s.}\ 4\frac{1}{4}\text{d.}\times1\times100}{3\frac{1}{2}\times325\frac{5}{8}}=\frac{46529\text{co far.}\times100\times2\times6}{7\times1955}$$
$$=\tfrac{8\,8\,8\,4\,8\,0\,0}{1\,3\,0\,1\,5}\text{ far.}$$
$$=4080\text{ far.}=\underline{£4\tfrac{1}{2}}. \text{ Ans.}$$

2. A school contains 380 scholars, 5 per cent. are between the ages of 12 and 14; 10 per cent. between 10 and 12; 35 per cent. between 8 and 10, and the remainder under that age; find the number of each class.

5 p. c. of 380 = $\frac{1}{20}$ of 380 = $\underline{19}$ between 12 and 14. Ans.

10 p. c. of 380 = $\frac{1}{10}$ of 380 = $\underline{38}$ between 10 and 12. Ans.

35 p. c. of 380 = $\frac{7}{20}$ of 380 = $\underline{133}$ between 8 and 10. Ans.

∴ Remaining 50 p. c. or $\frac{1}{2}$ = $\underline{190}$ under 8. Ans.

3. Find the quantity of stock purchased by investing £504 in the 4 per cents. at 96; and the yearly income.

(*a*) 96 : 100 :: £504 : Quantity of stock.

$$\frac{£504\times100}{96}=\underline{£525}. \text{ Ans.}$$

(*b*) $\frac{£525\times4}{100}=\underline{£21}$ of income. Ans.

4. If a tradesman gains 5s. 6d. on an article which he sells for 22s., what is his gain per cent.?

Here 5s. 6d. is gained on 16s. 6d.

∴ $16\frac{1}{2}$s. : $5\frac{1}{2}$s. :: 100 : Gain p. c.

$$\frac{100\times5\frac{1}{2}}{16\frac{1}{2}}=\frac{1100}{33}=\underline{33\tfrac{1}{3}}. \text{ Ans.}$$

Grammar.

MALES AND FEMALES.

1. Analyse this sentence, and comment on the meaning and use of the words 'but' and 'his.'

'There's not the smallest orb which thou beholdest
But in *his* motion like an angel sings.'

ANALYSIS.

Sentence.	Kind.	Subject.	Predicate.	Object.	Extension	Connective.
(1) There's not the smallest orb	Principal	the smallest	is not (= exists not)		there (*merely introductory*)	
(2) which thou beholdest	Subord. adj. to (1)	thou	beholdest	which		which
(3) But in his motion like an angel sings.	Subord. adj. to (1)	But = which not	sings		in his motion (*cause*) like an angel (*manner*)	but

'*But*' as here used is equivalent to 'which not' or 'that not,' and for a negative restriction is a very emphatic form.

'*His*' is the genitive of *it* as used in the Bible and Shakespeare. 'Its' is not found in the former, and rarely in the latter.

2. What is the root, and what is the exact meaning of each of these words :—Importation, Coeval, Submarine, Inaudible?

Give in each case, three other English words derived from the same root?

WORD.	ROOT.	MEANING.	EXAMPLES.
Importation	portare	a carrying in	export, report, comport
Coeval	ævum	living at the same time	primeval, eternal, age
Submarine	mare	under the sea	transmarine, maritime, ultramarine
Inaudible	audire	not able to be heard	audience, audit, auditor.

3. Name any English words which relate either to law or military affairs, and which are of Norman-French origin.

Law terms:—Assize, attorney, chancellor, court fee, felony, parliament, plaintiff.

Military terms:—Arms, assault, battle, chivalry, tournament, lance, mail, hauberk.

4. Paraphrase the following passage, and point out what images or metaphors are contained in it:—

'How gloriously her gallant course she goes!
Her white wings flying,—never from her foes;
She walks the waters like a thing of life
And seems to dare the elements to strife.
Who would not brave the battle fire, the wreck,
To move the monarch of her peopled deck?'—BYRON.

What a grand spectacle is a ship speeding along in full sail! Her sails, spread out like wings, make her scud along; but they are not spread to carry her away from her enemies. She cuts the waters as if she was a living creature, anxious to try her strength with the storm. Any man would be proud to face the hurricane of shot or tempest only to command a crew in such a gallant ship.

FIGURES OF SPEECH.

We have an example of *apostrophe* in 'How gloriously her gallant course she goes'; of *metaphor*, in 'her white wings flying;' of *personification*, in 'she walks'; of *simile*, in 'like a thing of life and seems, etc., to strife'; of *interrogation*, in 'who etc., deck'; of *metaphor*, in 'the monarch'; and of *metonymy*, in 'her peopled deck.'

Geography.

(*Answer either Q. 2 or Q. 3, not both.*)

1. Give notes of a lesson on The Rocky Mountains; describing their position, general character, wild animals, the rivers that rise in them, and any railway that crosses them. Illustrate by a map, and insert the lines of latitude and longitude.

N.B.—*Keep in mind that the object of 'Notes' is to show how you would make each point clear and interesting to children. Introduce any anecdotes that would enliven the lesson.*

THE ROCKY MOUNTAINS.

POSITION AND GENERAL CHARACTER.—These mountains form the backbone of N. America, stretching from north to south. They are very lofty, wild, and rugged, the highest summit being Mt. Hooker, in Canada, 16,000 feet (compare with Ben Nevis or Snowdon), lower slopes densely wooded, higher up grassy slopes, variegated with bright-coloured flowers; summits are masses of rock clad with eternal snow. They extend from the Arctic Ocean S. through Canada and U. States. The tablelands immediately east of the Rocky Mts. are generally barren, but further east there are wide prairies, covered with long grass (*describe settler's team of bullocks crossing prairie*).

WILD ANIMALS.—The principal wild animals are the bison or buffalo, frequenting the plains at the foot of the Mts. (*give an account of a buffalo-hunt*), moose-deer, caribou or reindeer, elk, bear, wolf, spotted tiger, American panther, and argali.

RIVERS.—The only important river of Canada west of the Mts. is the Fraser, with a winding course among the hills and tablelands of British Columbia. The scenery on it is very grand. The Saskatchewan flows east to L. Winnipeg. In the United States the Colorado crosses the broad tableland between the Rocky Mts. and the Sierra Nevada, and flows into the Gulf of California. The Columbia further north flows into the Pacific. The Missouri forms with the Mississippi one of the greatest rivers in the world. The former is navigable for 1500 miles above the junction, and the junction is 800 miles from the sea. Large steamers, many of them with three decks, are constantly plying up and down the river.

RAILWAYS.—Two Pacific railways cross the Rocky Mts., one in Canada, and the other in the States. The former is scarcely completed. The latter has been in operation for some time, crossing the Continent from New York, past Omaha and Ogden, to San Francisco.

2. What are the *tropics?* What parts of the world lie between them? What is the effect of this situation on their climate. And why?

On the terrestrial globe we find what are termed parallels of latitude and meridians of longitude at every 10° or 15°. Besides these, at 23½° on either side of the equator are the tropics; the north one is the tropic of Cancer, the southern one is the tropic of Capricorn. Between these tropics is the torrid zone, which is the hottest part of the earth, from the reason that the sun is vertical over every place within it two days in the year. The more nearly the sun approaches the zenith of a place the more powerful is the heat.

The parts of the world lying in the torrid zone are the southern halves of Arabia and India, nearly the whole of Further India, with a small part of China, the whole of the East India Islands; the whole of Africa (except the states bordering on the Mediterranean, the northern third of the Sahara, Cape Colony, Natal, the Transvaal, and Namaqua Land), the greater part of Madagascar; the third part of Australia; Central America, with the most of the West India Islands, and more than the half of S. America.

3. What reasons can you give for believing that the earth and the other planets move round the sun?

Perhaps the most satisfactory reason for believing that the earth moves round the sun is the simple way in which the movement accounts for the seasons and all the appearances in the motions of the other heavenly bodies. The apparent motions of the planets among the stars are much more irregular than those of the sun and moon; but the theory of their revolution round the sun in conjunction with that of the earth, affords a simple explanation of all their irregularities.

Needlework.

Two hours and a half allowed.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination papers.

SECOND PAPER.

Arithmetic.

Two hours and a half allowed.

MALES.

1. If a bank pays 12½ per cent. dividend, what interest should I get by purchasing £5 shares for £12 5s.?

£12½ : £5 :: £12½ : Interest required.

$$\frac{£12\tfrac{1}{2} \times 5}{12\tfrac{1}{2}} = \frac{50 \times 5}{49} = \underline{5\tfrac{5}{49} \text{ p. c.}} \text{ Ans.}$$

2. If the present value of a bill due 9 months hence, interest being at 4½ per cent., be £1700, what is the amount of the bill?

Interest on £100 for 9 mos. at 4½ = 3¾
Amount of ,, ,, ,, = 103¾
∴ 100 : 1700 :: 103¾ : Amount required.

$$\frac{£827 \times 1700}{8 + 100} = £1757\tfrac{1}{8} = \underline{£1757\ 7s.\ 6d.} \text{ Ans.}$$

3. If a man has £3600 railway stock paying 4½ per cent., how much would he gain annually if he sold out at 124¼ and invested the proceeds in 6 per cent. debentures at 143⅞, brokerage being charged on each transaction?

(*a*) £3600 brings 124¾ per 100 = £4491
∴ £144 : £4491 :: £6 : 2nd income.

$$\frac{£6 \times 4491}{144} = £187\ 2\ 6 \text{ 2nd income}$$

(*b*) £3600 at 4½ p. c. = 162 0 0 1st ,,
Annual gain = 25 2 6 Ans.

4. In a train the number of 1st class to the number of 3rd class passengers was as 2 : 15, and the fare for 1st class to the fare for 3rd class as 7 : 3. How much did the whole of each class pay if the amount received was £29 10s.?

2 : 15 :: no. of 1st class : no. of 3rd class passengers.
7 : 3 :: fare of ,, : fare of ,, ,,
14 : 45 :: value of all 1st : value of all 3rd
∴ 59 : 14 :: £29 10s. : £7 for 1st class. Ans.
59 : 45 :: £29 10s. : £22 10s. 3rd do. Ans.

History.

MALES AND FEMALES.

1. At what period of our history has the chief power been with the Sovereign, the nobility, and the commonalty respectively? Where would you say it is now?

Under the Tudors, who came into possession of the Crown after the Wars of the Roses, there began a constitutional retrogression, in which the slow work of the previous age was rapidly undone. Parliamentary life was almost suspended or turned into a formality by the overpowering influence of the Crown. The legislative powers of the two Houses were usurped by the Royal Council. Arbitrary taxation reappeared in benevolences and forced loans. The freedom which had been won when the influence of the barons under De Montfort was all powerful, and its tradition had been watched over by the Church, but with the battle of Towton feudalism was swept away, and the baronage lay a mere wreck, after the storm of the Civil War. The new monarchy, which came in with the Tudors, was completely demolished by the Long Parliament of 1640, when the commonalty got the upper-hand and kept it, more or less, till a constitutional Government of King, Lords, and Commons, took its sway. It is not far wrong to say that the chief power now lies in the Commons.

2. 'Sir R. Walpole's financial scheme was to change customs into excise duties, and to make London a free port for the whole of Europe.' Explain this 'scheme' and the grounds of opposition to it.

Customs are duties levied on foreign productions when landed on British shores; excise is a tax levied on articles manufactured in Britain. To check smuggling, which was very openly carried on at the time, Walpole proposed to bring wine and tobacco under the excise. By the increase of trade, and of money thus levied, the land-tax, he said, might be abolished in course of time. The total abolition of the land-tax was meant to satisfy the county gentlemen, and the bonding or warehousing of wine was an immense advantage to the merchant. Yet the vehemence of ignorant opposition was not softened. One declared that in all countries excises of every kind were looked upon as badges of slavery; merchants declared that they wou'd be ruined, and the Opposition took up the same cry, imagining that they saw a whole army of excisemen ready at any time to vote as Walpole desired.

3. 'The battles of Austerlitz and Trafalgar were nearly contemporaneous;' contrast them and their consequences.

In 1805 Nelson met *the combined French and Spanish fleets* off Cape Trafalgar. Here this great sailor, though at the cost of his own life, attacked and defeated them, and thus *completely destroyed the power of the French at sea*. . . . But if Napoleon lost this great naval action he gained a victory on land two months after which more than made up for the loss. At Austerlitz, in Moravia, this untiring general fell upon *the combined Austrian and Russian armies*, and defeated them with immense slaughter. The victory of Austerlitz, which *marks the highest point in Napoleon's career*, broke Pitt's heart. 'Roll up that map,' he said pointing to the map of Europe; 'it will not be wanted for ten years.' Sad and dejected he died in a few weeks, and it so happened that Nelson and Pitt—two of the greatest men England ever produced—were carried to the grave in the same month.

Teaching.

Write out notes of a lesson on *The Arctic Regions*.

POSITION AND EXTENT.—A circle round the earth at 1600 miles from the North Pole as a centre is called the Arctic Circle (*arktos*, a bear, the north)—all the land and sea within this circle forms the Arctic regions or North Frigid Zone—covers a space larger than the whole of Europe—extends through the North of Europe, Asia, and America round the globe. (*Refer to map, or better, to the globe.*)

CHARACTER.—Not a tree can be found in it; even the hardiest plants are stunted in growth and become creepers. In the middle of these regions the sun is one half of the year above the horizon and the other half below it—one long dreary night of six months—gloom often relieved by the magnificent spectacle of the Aurora Borealis—this shines with a brilliancy unknown elsewhere. (*Give or read a description of this.*)

ARCTIC OCEAN.—This is studded with islands—most of them lying along coast of America—largest is Greenland (*d scribe*)—for three centuries navigators tried to discover a *north-west passage* to the Pacific (*show on globe or map*)—most notable attempt that by Sir John Franklin, who was successful but lost his life (*reference to late attempts to reach the Pole and to the north-east passage*).

PARTS OF ARCTIC REGIONS.—In *Europe* north part of Norway is within Arctic Circle—climate milder owing to warm water of the Atlantic—Lapland and small part Russia also within the Circle. In *Asia* the north, where three mighty rivers—Obi, Lena, Yenesei—enter the sea, becoming more and more clogged with ice as they near it, and they overflow their banks, making this part of Asia a dismal swamp without pasture. In *America* the Arctic portion is covered with snow and ice nearly the whole of the year—in winter an awful silence reigns—scarcely a living creature—when summer ends the flocks of birds that made their appearance in the spring to feed along the coasts return to the south, darkening the air with their numbers.

ANIMALS.—Whale, walrus, seal, in the sea; Polar bear, Arctic fox, reindeer, on land.

INHABITANTS.—Laps in Lapland; Esquimaux in Arctic America; Samoiedes in Arctic Russia.

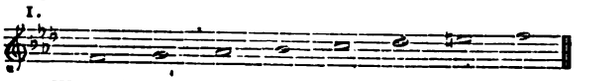
Music.

A quarter of an hour allowed for this paper.

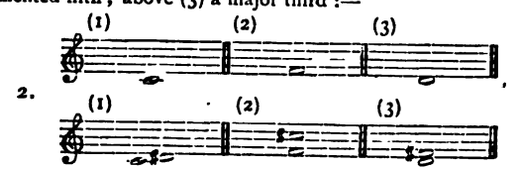
(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write in the treble clef the signature and the ascending scale of F minor, using the minor or flat sixth and the major or sharp seventh.

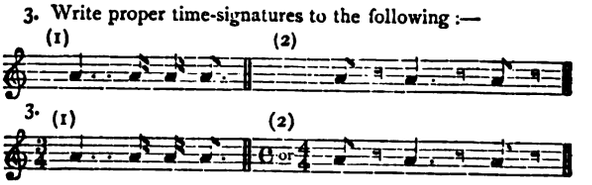
1.



2. Write above (1) an augmented second; above (2) an augmented fifth; above (3) a major third :—



3. Write proper time-signatures to the following :—



TONIC SOL-FA NOTATION.

1. Write (1) above *doh* an augmented second; (2) above *fah* an augmented fifth; (3) above *ray* a major third.

1. (1) *doh* to *re*; (2) *fah* to *de*; (3) *ray* to *fe*.

2. In the minor or *lah* mode (1) which is the essential or minor sixth; and (2) which is the essential or major seventh?

2. (1) *fah*; (2) *se*.

3. Write the following in six-pulse measure by trebling the value of every note :—

|s ,-,l :s ,d ,- |m ,- ,r :d ‖

3. |s :—:l |s :d :—|m :—:r |d :—:—‖

SCHOOL-SONG MONEY PRIZE COMPETITION.

Mr. HUGHES has the pleasure to announce the following prizes.

FOR THE BEST SCHOOL SONG. (Not Action.)	
1st Prize	2 Guineas.
2nd ,, ...	1 Guinea.

FOR THE BEST ACTION SONG FOR INFANTS.	
1st Prize	2 Guineas.
2nd ,, ...	1 Guinea.

*** *The Prizes will be paid within twenty-one days of the Judge's Awards.*

RULES.

1. This competition is restricted to Subscribers to the PRACTICAL TEACHER.
2. The *words* used must either be *original* or *non-copyright.*
3. No song should bear the competitor's real name and address, but only the pseudonym adopted. The real name and full postal address should be sent in a separate letter, stating the pseudonym adopted by the sender, the name of the song, and whether the words are original or non-copyright.
4. No appeal from the Judge's decision can be entertained.
5. All songs (words and music) become the copyright of Mr. Hughes upon payment of the amount offered.
6. For obvious reasons no regular contributor to the PRACTICAL TEACHER will be allowed to compete.

No song can be received after April 1st, 1884.

Query Column.

RULES.

1. Each correspondent is restricted to *one question*. We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.

2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.

3. ☞ When a pseudonym is adopted it should be written at the end of the query, and the real name and address on a separate piece of paper.

4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.

5. Replies will not be sent through the post.

6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—'*The Query Editor*,' *The Practical Teacher*, *Pilgrim Street, Ludgate Hill, London, E.C.*

Arithmetic.

1. JEAN.—If a man for 4 days running spends each day $\frac{1}{3}$ of what he had at the beginning of the day, and then has 10s. left, how much had he at first? (*Bryant.*)

Part left after 1st day $= \frac{2}{3}$ of original amount;
" " 2nd " $= \frac{2}{3}$ of $\frac{2}{3}$ " "
$= \frac{4}{9}$ " ";
" " 3rd " $= \frac{2}{3}$ of $\frac{4}{9}$ " "
$= \frac{8}{27}$ " ";
" " 4th " $= \frac{2}{3}$ of $\frac{8}{27}$ " "
$= \frac{16}{81}$ " ";
$\frac{16}{81}$ of original amount = 10s.,
∴ Original amount = 10s. $\times \frac{81}{16}$
$= \frac{405}{8}$s.
$= £2\ 10s.\ 7\frac{1}{2}d.$ Ans.

Note.—We believe your writing would obtain 90 per cent. of marks. It is rather *too small*.

2. YOUNKER.—I buy wheat at 39s. a quarter, and some of a superior quality at 6s. a bushel; in what proportions must I mix them, so as to gain 25 per cent. by selling the mixture at 57s. 6d. per quarter? (*Hamblin Smith.*)

Cost price of mixture = 57s. 6d. $\times \frac{100}{125}$
$= 57s.\ 6d. \times \frac{4}{5}$
$= 46s.$;
Difference between cost price of mixture and 1st kind = 46s. − 39s.
$= 7s.$;
" " " " 2nd " = 48s. − 46s.
$= 2s.$;
∴ Quantity of 1st kind : Quantity of 2nd kind :: 2s. : 7s.
:: 2 : 7 Ans.

3. H. BULL.—The hour and minute hands of a watch are together at 12 o'clock; when will they next be together?

The minute hand moves twelve times as fast as the hour hand;
∴ The difference between the rates of the minute and hour hands is eleven times the rate of the hour hand.
∴ They will not be together between 12 and 1. The minute hand must gain 5 minutes on the hour hand to be together between 1 and 2;
∴ Distance gone by hour hand = 5 min. ÷ 11
$= \frac{5}{11}$ min.;
∴ The hands will next be together at $5\frac{5}{11}$ min. past 1. Ans.

4. W. T. NORTON.—A and B can do a piece of work in 10 days, B and C in 15 days, and A and C in 25 days; they all work at it for 4 days, A then leaves, and B and C go on for 5 days, B then leaves. In how many days will C finish the work? (*Barnard Smith.*)

A and B can do the work in 10 days,
B and C " " 15 " ,
A and C " " 25 " ;
∴ A and B can do in 1 day $\frac{1}{10}$ of the work,
B and C " " " $\frac{1}{15}$ " ,
A and C " " " $\frac{1}{25}$ " ;
∴ 2(A, B, and C) can do in 1 day $(\frac{1}{10} + \frac{1}{15} + \frac{1}{25})$ of the work
$= \frac{15+10+6}{150}$ " "
$= \frac{31}{150}$ " "
∴ A, B, and C can do in 1 day $(\frac{31}{150} \div 2)$ " "
$= \frac{31}{300}$ " "
∴ C can do in " $(\frac{31}{300} - \frac{1}{10})$ " "
$= \frac{31-30}{300}$ " "
$= \frac{1}{300}$ " "
Part don by all in 4 days $= \frac{31}{300} \times 4$
$= \frac{31}{75}$;
Part done by B and C in 5 days $= \frac{1}{15} \times 5$
$= \frac{1}{3}$;
∴ Part remaining to be done $= 1 - (\frac{31}{75} + \frac{1}{3})$
$= 1 - \frac{31+25}{75}$
$= 1 - \frac{56}{75}$
$= \frac{19}{75}$;
∴ C can finish the work in $(\frac{19}{75} \div \frac{1}{300})$ days
$= (\frac{19}{75} \times 300)$ days
$= 76$ days. Ans.

5. BILL AND WILLIE.—A boy playing at marbles lost in the first hour all he had, and got into debt for half a dozen more; in the second hour he gained double of all that he had lost in the first, and 40 per cent. besides of the number he started with, which, after he had paid his debt, increased his total store of marbles at the end of his play by 48; what number had he to start with? (*Pupil Teachers' Exam.*, July, 1877.)

Gain on the two hours' play = (100 + 40) per cent. of original number and 6 marbles more;
Marbles. Marbles. Marbles.
∴ 140 : 48 − 6 :: 100 : Original number of marbles.
Marbles.
$\cancel{140}$: $\cancel{42}$ :: $10\cancel{0}$: Original number.
3
= 30 marbles. Ans.

6. DEVONIAN.—The sum of £760 is divided between A, B, C. The shares of A and B together exceed the share of C by £240, and the shares of B and C together exceed the share of A by £360. What is the share of each? (*Hamblin Smith*).

A's share + B's share = C's share + £240,
But, " + " = £760 − C's share;
∴ C's share + £240 = £760 − C's share,
Twice C's share = £760 − £240
= £520,
∴ C's share = £260.

B's share + C's share = A's share + £360,
Bu " + " = £760 − A's share;
∴ A's share + £360 = £760 − A's share,
Twice A's share = £760 − £360
= £400,
∴ A's share = £200.
B's share = £760 − (£200 + £260)
= £760 − £460
= £300.

Note.—*John Stuart Mill's* 'Political Economy.'

7. AXIOM.—Eleven cubic inches of iron weigh as much as seven cubic inches of lead, and the price per ton of lead is £15, of iron £4. The value of a certain block of lead is £36 17s. 11d.; what would be the value of a block of iron of the same size?

Cub. in. : Cub. in. :: £ s. d. :: 36 17 11 : Value of block of iron.
11 : 7
£ : £
15 : 4

∴ Value of block of iron $= \frac{£36\ 17s.\ 11d. \times 7 \times 4}{11 \times 15}$
$= \frac{£1033\ 1s.\ 8d.}{165}$
$= £6\ 5s.\ 2\frac{8}{11}d.$ Ans.

8. SEMPER IDEM.—By selling apples at 3 for a penny, I gain 5 per cent.; what do I gain or lose per cent. by selling them at £1 per 1000? (*Pupil Teachers' Examination.*)

£ d. £
$\frac{1}{21}$: $\frac{1}{3}$ :: $\frac{1}{20}$: Cost price of each apple;
$= \frac{20}{21}d.$
Cost price of 1000 apples $= (\frac{20}{21} \times 1000)d. = \frac{20000}{21}d.$
d. £ d. d.
$\frac{20000}{21}$: 100 :: $(\frac{20000}{21} - 240)$: Loss per cent.
d. £ d.
$\frac{2000}{21}$: 1 :: $\frac{4000}{21}$: Loss per cent.
∴ Loss per cent. $= \frac{4000}{2000} = 1\frac{2}{3} = 24\frac{2}{3}$. Ans.

9. LIZZIE.—Bought a quantity of quills at 4s. 7d. a hundred, and sold them so as to gain $\frac{1}{3}$ of the selling price. What was the selling price, and what was the profit per cent. on the cost price? (*Moffatt's* 'Pupil Teachers' Course.')

Selling price = cost price + $\frac{1}{3}$ of selling price,
Selling price − $\frac{1}{3}$ of selling price = cost price,
$\frac{2}{3}$ selling price = cost price,
∴ Selling price = cost price × $\frac{3}{2}$
= 4s. 7d. × $\frac{3}{2}$
= (11 × 3)d.
= 7s. 4d. Ans.

s. d.
7 4
s. d. £ 4 7
∴ 4 7 : 20 :: 2 9 : Gain per cent.
12 12
33 33
3
= £60.
∴ Gain = 60 per cent.

10. PRÆCEPTOR.—If the ratio of threepenny to fourpenny pieces in a given sum, which consists entirely of those coins, were altered from 3 : 7 to 7 : 3, the sum would be diminished by £20. Find the sum. (*Scholarship*, 1883.)

Amount of 3 threepenny and 7 fourpenny pieces
= (3d. × 3) + (4d. × 7) = 9d. + 2s. 4d. = 3s. 1d.;
Amount of 7 threepenny and 3 fourpenny pieces
= (3d. × 7) + (4d. × 3) = 1s. 9d. + 1s. = 2s. 9d.;
Difference between these amounts = 3s. 1d. − 2s. 9d. = 4d.
d. £ s. d.
∴ 4 : 20 :: 3 1 : Sum.
5 12
37
= £185. Ans.

11. A. B. C.—A man having bought a lot of goods for £150 sells $\frac{1}{3}$ at a loss of 4 per cent.; by what increase per cent. must he raise that selling price, in order that, by selling the rest at the increased rate, he may gain 4 per cent. on the whole transaction?

Selling price of $\frac{1}{3}$ of goods = £50 − £2 = £48;
Gain on the whole transaction = £150 + £6 = £156;
∴ Remainder must be sold for £156 − £48 = £108;
Former selling price = £96 for goods costing £100;
∴ Difference = £108 − £96 = £12;

£ £ £
∴ 96 : 100 :: 12 : Increase per cent.
8 25
2
= 12½ per cent. Ans.

12. JUMBO.—In billiards A can give B 5 in a game of 50, and C 10 points in 50; how many points can B give C in a game of 90?

A can give B 5 points in 50,
" " C 10 " " ;
∴ B makes 45 points, while A makes 50,
C " 40 " " " " ;
∴ B can give C 5 points in 45,
" " " 10 " 90.

13. ACME.—Simplify:—

$$\frac{2{\cdot}031746 \times 8{\cdot}818952380}{{\cdot}158730}.$$

$$\frac{2{\cdot}031746 \times 8{\cdot}818952380}{{\cdot}158730}$$
$$= \frac{2\frac{31746}{100000} \times 8{\cdot}818\frac{95238}{100000}}{\frac{15873}{100000}} = \frac{\frac{203174}{100000} \times 8\frac{(818 \times 21) + 20}{21000}}{\frac{15873}{100000}}$$
$$= \frac{\frac{203174}{100000} \times 8\frac{17198}{21000}}{\frac{15873}{100000}} = \frac{128}{873} \times \frac{92599}{10500} \times \frac{873}{10}$$
$$= \frac{11852672}{105000} = \frac{11852{\cdot}672}{105} = \frac{2370{\cdot}5344}{21} = \frac{7\text{,}50{\cdot}17813}{7}$$
$$= 112{\cdot}882560476\dot{1}. \text{ Ans.}$$

Note.—You have worked the other query correctly. The most expeditious way is to multiply the difference of the cubes of the diameters by ·5236.

Algebra.

1. BRYNAROOR.—Find the value of x in the following equation:—

$$(a+bx)(cx+d') = (a+b)(c+dx).$$

(*Atkin's* 'Mathematics.')

$$(a+bx)(cx+d') = (a+b)(c+dx)$$
$$acx + bcx^2 + ad + bdx = ac + bc + adx + bdx$$
$$bcx^2 + acx - adx = ac + bc - ad$$
$$x^2 + \frac{(ac-ad)x}{bc} = \frac{ac+bc-ad}{bc}$$
$$x^2 + \frac{(ac-ad)x}{bc} + \left(\frac{ac-ad}{2bc}\right)^2 = \frac{ac+bc-ad}{bc} + \frac{(ac-ad)^2}{4b^2c^2}$$
$$= \frac{(ac-ad)^2 + 4bc\,ac + bc - ad}{4b^2c^2}$$
$$= \frac{(ac-ad)^2 + 4bc(ac-ad) + 4b^2c^2}{4b^2c^2}$$
$$= \frac{(ac-ad+2bc)^2}{4b^2c^2}$$
$$x + \frac{ac-ad}{2bc} = \pm\frac{ac-ad+2bc}{2bc}$$
$$x = \pm\frac{ac-ad+2bc}{2bc} - \frac{ac-ad}{2bc}$$
$$= \frac{2bc}{2bc}, \text{ or } \frac{2ad-2ac-2bc}{2bc}$$
$$\therefore\ x = 1, \text{ or } \frac{ad-(a+b)c}{bc}.$$

2. CORRESPONDENT.—Simplify the expression:—

$$3a - [b + \{2a - (b-c)\}] + \tfrac{1}{2} + \frac{2c^2 - \frac{1}{2}}{2c+1}.$$

(*Todhunter.*)

$$3a - [b + \{2a - (b-c)\}] + \tfrac{1}{2} + \frac{2c^2 - \frac{1}{2}}{2c+1}$$
$$= 3a - [b + 2a - b + c] + \tfrac{1}{2} + \frac{4c^2 - 1}{2(2c+1)}$$
$$= 3a - [2a + c] + \tfrac{1}{2} + \frac{2c-1}{2}$$
$$= 3a - 2a - c + \tfrac{1}{2} + c - \tfrac{1}{2}$$
$$= a. \text{ Ans.}$$

3. ENQUIRER.—Extract the square root of 25,400,544 in the scale of 6; transform 3,065·263 from the scale of 8 to the scale of 10; reduce $\frac{1}{18}$ from the scale of 10 to a duodecimal fraction. (*Lower Division*, May, 1883.)

$$
\begin{array}{r|l}
 & 25'40'05'44(4,112 \\
 & 24 \\
\hline
121 & 140 \\
 & 121 \\
\hline
1221 & 1505 \\
 & 1221 \\
\hline
12222 & 24444 \\
 & 24444 \\
\hline
\end{array}
$$

∴ Square root of 25,400,544 in the scale of 6 = 4,112.

$$
\begin{array}{r|l}
10 & 3065 \text{ in the scale of } 8 \\
\hline
10 & 236\ldots 9 \\
\hline
10 & 17\ldots 8 \\
\hline
 & 1\ldots 5
\end{array}
$$

∴ 3,065 in the scale of 8 = 1,589 in the scale of 10.

·263 in the scale of $8 = \frac{2}{8} + \frac{6}{8^2} + \frac{3}{8^3}$

$= \frac{141}{512}$ in the common scale

$= \cdot 349609375$ in the scale of 10.

∴ 3.065·263 in the scale of 8

= 1,589·349609375 in the scale of 10.

$\frac{1}{4} \times 12 = \frac{1}{3}$,

$\frac{1}{3} \times 12 = 3$;

∴ $\frac{1}{43}$ in the scale of 10 = ·03 in the scale of 12.

Note.—(1) In the common or decimal notation the value of the figures representing any number increases from right to left, by powers of *ten*.

Thus, $7296 = 7 \times 10^3 + 2 \times 10^2 + 9 \times 10 + 6$.

Now, although this employment of 10 as the *radix*, as it is called, of our scale of notation is convenient, it is quite arbitrary; and we might express any number by means of powers of any other number than 10.

For instance, if 4 were taken as the radix of the scale of notation, 2312 would denote $2 \times 4^3 + 3 \times 4^2 + 1 \times 4 + 2$.

Similarly, if 8 were the radix of the scale, 5764 would mean $5 \times 8^3 + 7 \times 8^2 + 6 \times 8 + 4$.

The numbers here represented by 2312 and 5764 are said to be expressed in the scales of 4 and 8 respectively.

It is evident that each of the figures or digits which occur in any scale must be less than the radix of the scale. Thus, in the scale of 4, the largest digit or figure which can occur is 3; in that of 8, 7; and similarly for other scales.

Suppose we take 12 for the radix of the scale, we must have symbols to represent the numbers 10 and 11. If we use *t* and *e* respectively for them, then 57*t*4*e*9 would mean

$5 \times 12^5 + 7 \times 12^4 + 10 \times 12^3 + 4 \times 12^2 + 11 \times 12 + 9$.

The scale of which the radix is 12 is called the *duodecimal* or *duodenary* scale.

(2) Your writing might obtain 70 per cent. of marks. It is *too small*.

4. INQUISITIVE.—The distance from A to B is $7\frac{1}{2}$ miles; a man can walk it in 2 hours 20 minutes, and return in 2 hours $17\frac{1}{2}$ minutes. He walks uniformly on both journeys at the following rates—up hill, 3 miles per hour; down hill, $3\frac{1}{2}$ miles per hour; and on the level at $3\frac{1}{3}$ miles per hour; how *much level* is there between A and B? (*Dublin University B.A. Paper.*)

Let x = level ground between A and B in miles,

And let y = up-hill ,, from A to B in miles;

Then $7\frac{1}{2} - (x+y)$ = down-hill ,, ,, ,, ;

∴ y = ,, ,, ,, B to A ,, ;

And $7\frac{1}{2} - (x+y)$ = up-hill ,, ,, ,, ,, ;

$$\therefore \text{(1)}\ \frac{x}{3\frac{1}{3}} + \frac{y}{3} + \frac{7\frac{1}{2} - (x+y)}{3\frac{1}{2}} = 2\frac{1}{2}$$

$$\text{(2)}\ \frac{x}{3\frac{1}{3}} + \frac{7\frac{1}{2} - (x+y)}{3} + \frac{y}{3\frac{1}{2}} = 2\frac{7}{24}$$

$$\text{(1)}\ \frac{4x}{13} + \frac{y}{3} + \frac{15 - 2x - 2y}{7} = \frac{7}{2}$$

$$\text{(2)}\ \frac{4x}{13} + \frac{15 - 2x - 2y}{6} + \frac{2y}{7} = \frac{55}{24}$$

$$\text{(1)}\ 84x + 91y + 585 - 78x - 78y = 637$$

$$\text{(2)}\ 672x + 5460 - 728x - 728y + 624y = 5005$$

$$\text{(1)}\ 6x + 13y = 52$$

$$\text{(2)}\ -56x - 101y = -455$$

$$\text{(1)}\ 48x + 104y = 416$$

$$\text{(2)}\ 56x + 104y = 455$$

$$8x = 39$$

$$\therefore x = 4\tfrac{7}{8}.$$

∴ Level ground = $4\frac{7}{8}$ miles. Ans.

5. R. J. SMITH.—Solve:—

$$2x^2 + 6x = 226 - \sqrt{x^2 + 3x - 8}. \quad (\textit{Todhunter.})$$

$$2x^2 + 6x = 226 - \sqrt{x^2 + 3x - 8}$$

$$x^2 + 3x = 113 - \tfrac{1}{2}\sqrt{x^2 + 3x - 8}$$

$$(x^2 + 3x - 8) + \tfrac{1}{2}\sqrt{x^2 + 3x - 8} = 113 - 8 = 105$$

$$(x^2 + 3x - 8) + \tfrac{1}{2}\sqrt{x^2 + 3x - 8} + (\tfrac{1}{4})^2 = 105 + \tfrac{1}{16} = 105\tfrac{1}{16}$$

$$\sqrt{x^2 + 3x - 8} + \tfrac{1}{4} = \pm 10\tfrac{1}{4}$$

$$\sqrt{x^2 + 3x - 8} = \pm 10\tfrac{1}{4} - \tfrac{1}{4} = 10, \text{ or } -10\tfrac{1}{2}.$$

(The minus value is inapplicable, as the square root of a positive quantity is positive.)

$$\sqrt{x^2 + 3x - 8} = 10$$

$$x^2 + 3x - 8 = 100$$

$$x^2 + 3x = 108$$

$$x^2 + 3x + (\tfrac{3}{2})^2 = 108 + \tfrac{9}{4} = 117\tfrac{9}{4}$$

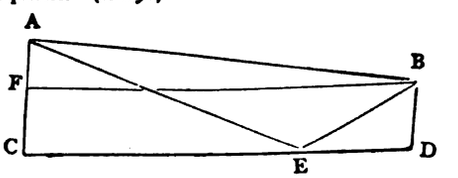
$$x + \tfrac{3}{2} = \pm 10\tfrac{1}{2}$$

$$x = \pm 10\tfrac{1}{2} - \tfrac{3}{2}$$

$$\therefore x = 9, \text{ or } -12.$$

Mensuration.

1. CONSTANT SUBSCRIBER.—There are two upright pillars in the same horizontal plane, whose heights are respectively 44 ft. and 28 ft. A certain point is taken in that plane between the two pillars, and it is found that the distance of *this point* from the top of the higher pillar is 125 ft., and from the top of the shorter pillar is 53 ft. Find the distance between the tops of these pillars. (*Hiley.*)



$$CE^2 = AE^2 - AC^2$$

$$= 125^2 - 44^2$$

$$= 15625 - 1936$$

$$= 13689;$$

$$\therefore CE = 117.$$

$$DE^2 = BE^2 - BD^2$$

$$= 53^2 - 28^2$$

$$= 2809 - 784$$

$$= 2025;$$

$$\therefore DE = 45.$$

$$CD = CE + DE$$

$$= 117 + 45$$

$$= 162.$$

$$AB^2 = AF^2 + FB^2$$

$$= (44 - 28)^2 + CD^2$$

$$= 16^2 + 162^2$$

$$= 256 + 26244$$

$$= 26500;$$

$$\therefore AB = \sqrt{26500}$$

$$= 162{\cdot}788\ldots\ldots$$

∴ Distance between the tops of the pillars

= 162·788...ft. Ans.

2. BON SOIR.—A tent is made in the form of a conic frustrum surmounted by a cone of a different angle. The diameters of the base and top of the frustrum are 14 ft. and 7 ft., its height is 8 ft., and the height of the tent 12 ft.; find the quantity of canvas required for it. (*Excise*, Nov., 1883.)

Slant height of lower part = $\sqrt{8^2 + (3\frac{1}{2})^2}$ ft.

$= \sqrt{64 + \frac{49}{4}}$ ft.

$= \sqrt{\frac{289}{4}}$ ft.

$= \frac{17{\cdot}4642\ldots}{2}$ ft.

$= 8{\cdot}7321\ldots$ft.;

,, ,, upper ,, $= \sqrt{4^2 + (3\frac{1}{2})^2}$ ft.

$= \sqrt{16 + \frac{49}{4}}$ ft.

$= \sqrt{\frac{113}{4}}$ ft.

$= \frac{10{\cdot}63\ldots}{2}$ ft.

$= 5{\cdot}315\ldots$ft.;

Quantity of canvas required for lower part

$$= \left\{ \frac{(14+7) \times 3{\cdot}14159}{2} \times 8{\cdot}7321 \right\} \text{ sq. ft.}$$
$$= \frac{576{\cdot}086238819}{2} \text{ sq ft.}$$
$$= 288{\cdot}0431194095 \text{ sq. ft.}$$

Quantity of canvas required for upper part

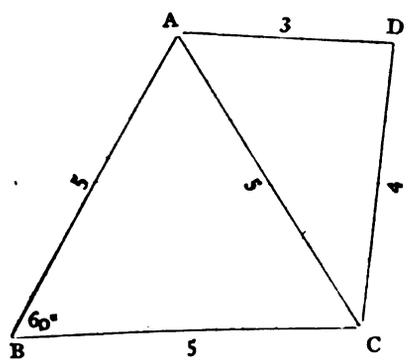
$$= \left(\frac{7 \times 3{\cdot}14159}{2} \times 5{\cdot}315 \right) \text{ sq. ft.}$$
$$= \frac{116{\cdot}88285595}{2} \text{ sq. ft.}$$
$$= 58{\cdot}441427975 \text{ sq. ft.}$$

∴ Quantity of canvas required for the tent
$= (288{\cdot}0431194095 + 58{\cdot}441427975)$ sq. ft.
$= 346{\cdot}4845473845$ sq. ft.
$= 38$ sq. yds. $4{\cdot}4845473845$ ft. Ans.

3. CHRONONHOTONTHOLOGOS.—The diagonals of a quadrilateral are 26 ft. and 24 ft. respectively, and they are at right angles; find the area. (*Todhunter.*)

Area of quadrilateral $= \frac{1}{2}(26 \times 24)$ sq. ft. $= (26 \times 12)$ sq. ft.
$= 312$ sq. ft. Ans.

4. YELSERP.—The sides of a quadrilateral taken in order are 5, 5, 4, and 3 feet respectively, and the angle contained by the first two sides is 60°; find the area. (*Todhunter.*)



In the triangle ABC, the sides AB, BC are equal, and the angle ABC is 60°, therefore it is equilateral.
As the sides of the triangle ADC are 3, 4, 5 respectively, it is right-angled, as $5^2 = 3^2 + 4^2$.

Area of equilateral triangle ABC $= \text{Side}^2 \times {\cdot}433$
$= 5^2 \times {\cdot}433 = 10{\cdot}825$;
,, right-angled triangle ADC $= \frac{1}{2}(3 \times 4) = 6$;
∴ Area of quadrilateral $= (10{\cdot}825 + 6)$ sq. ft.
$= 16{\cdot}825$ sq. ft. Ans.

5. M. A. M.—A public park surrounded by an iron railing measures 205 yds. long by 79 yds. broad. Inside the railing there is a gravel walk 6 feet wide. How many sq. ft. are in this walk?

Area of walk $= [\{(205+79) - (2 \times 2)\} \times 2 \times 2]$ sq. yds.
$= [\{284 - 4\} \times 4]$ sq. yds. $= [280 \times 4]$ sq. yds.
$= 1120$ sq. yds. $= 10{,}080$ sq. ft. Ans.

6. TREBOR.—In turning a one-horse chaise within a ring of a certain diameter, it was observed that the outer wheel made 3 turns while the inner wheel made 2. The wheels were of equal height; and supposing them fixed at a distance of 5 feet asunder on the axle-tree, what was the circumference of the track described by each wheel? (*Nesbit.*)

Circumference of inner track : Circumference of outer track
:: 2 : 3,
∴ Diameter of inner track : Diameter of outer track
:: 2 : 3,
Diameter of inner track : Diameter of inner track + 5 ft. × 2
:: 2 : 3,
∴ 3 times diameter of inner track
$= 2$ (diameter of inner track + 10 ft.)
= Twice diameter of inner track + 20 ft.
∴ Diameter of inner track = 20 ft.,
,, ,, outer ,, = 30 ft.;
∴ Circumference of inner track $= (20 \times 3{\cdot}1416)$ ft.
$= 62{\cdot}832$ ft.
,, ,, outer ,, $= (30 \times 3{\cdot}1416)$ ft.
$= 93{\cdot}248$ ft.

7. SEMPER FIDELIS.—A solid metal sphere of 6 inches diameter is formed into a tube 10 inches in external diameter and 4 inches in length. Find the thickness of the tube.

Solidity of sphere $= (6^3 \times {\cdot}5236)$ cub. in. $= (216 \times {\cdot}5236)$ cub. in.;
Solidity of tube = (External diameter^2 − internal diameter^2) × 7854 × length
$= \{(10 \text{ in.})^2 - \text{internal dia.}^2\} \times {\cdot}7854 \times 4$ in.
$= (100 \text{ sq. in.} - \text{internal dia.}^2) \times 3{\cdot}1416$ in.;
∴ $(100 \text{ sq. in.} - \text{internal dia.}^2) \times 3{\cdot}1416$ in.
$= (216 \times {\cdot}5236)$ cub. in.,

$$100 \text{ sq. in.} - \text{internal dia.}^2 = \frac{(216 \times {\cdot}5236) \text{ cub. in.}}{3{\cdot}1416 \text{ in.}} = 36 \text{ sq. in.}$$

Internal dia.$^2 = 100$ sq. in. − 36 sq. in. $= 64$ sq. in.
∴ Internal diameter = 8 inches.

Thickness of ring $= \frac{1}{2}$ (external diameter − internal diameter)
$= \frac{1}{2}(10 \text{ in.} - 8 \text{ in.}) = 1$ inch. Ans.

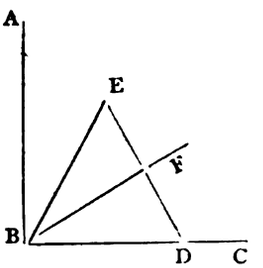
8. DEVA.—Two large circles are concentric with one which encloses 3927 ft.; find their radii (working to four places of decimals) so that the areas lying between the given circle and the second, and between the second and the outermost, may each equal the area of the given circle. (*Excise Exam.*, Nov., 1883.)

Area of second circle $= (3927 \times 2)$ sq. ft. $= 7854$ sq. ft;
Diameter ,, $= \sqrt{7854 \text{ sq. ft.} \div {\cdot}7854}$
$= \sqrt{10{,}000 \text{ sq. ft.}} = 100$ ft.;
∴ Radius ,, $= 50$ ft.

Area of outermost circle $= (3927 \times 3)$ sq. ft. $= 11{,}781$ sq. ft.;
Diameter ,, $= \sqrt{11{,}781 \text{ sq. ft.} \div {\cdot}7854}$
$= \sqrt{15{,}000 \text{ sq. ft.}} = 122{\cdot}4744\ldots$ ft.;
∴ Radius ,, $= 61{\cdot}2372\ldots$ ft.

Geometry.

1. E. COUMBE.—Trisect a right angle.



Let ABC be a right angle.
In BC take any point D, and upon BD describe an equilateral triangle BDE; (I. 1.)
Bisect the angle DBE by the straight line BF; (I. 9.)
Then BE and BF trisect the right angle ABC.

Proof.—The triangle BDE is equilateral, and therefore equiangular; (I., 5, Cor.)
The angles of a triangle are together equal to two right angles; (I. 32.)
∴ Angle DBE = $\frac{2}{3}$ of a right angle.
Wherefore angle ABE = $\frac{1}{3}$,, ,,
And angle DBE is trisected by BF,
∴ Each of the angles DBF, EBF = $\frac{1}{3}$ of a right angle.
Wherefore BE and BF trisect the right angle ABC.
Q. E. F.

General.

1. J. A. SIMPSON.—*Huxley* or *Findlater's* 'Physiography,' or *Langler's* 'Popular Astronomy' (Hughes), for the outlines of the subject.

2. ALLOTT EDDLEBERT will see the diagrams required in any atlas or large work on Astronomy. They may in due course appear in our own pages.

3. TEACHER.—No doubt the following explanation will remove your difficulty :—

$x^m \div x = x^{m-1}$, as the index of x is unity ;

$x^{m-1} \div x = x^{(m-1)-1} = x^{m-2}$.

4. E. COUMBE.—The solution of your query appeared in our issue for October, 1882.

5. MACDERMOT.—You will find the solution of your query in our issue for December, 1883.

6. E. SANDERS.—Your query was solved in our issue for April, 1882.

7. RAJAH.—(1) The solution of your query appeared in our issue for July, 1883. (2) We believe your writing would obtain the full percentage of marks.

8. CIVIL SERVICE INQUIRER.—Your writing is good, and would probably receive 80 per cent. of the marks awarded. Mr. Winch's handwriting (Dictation) in our last number will prove a capital model for you.

9. SUBSCRIBER.—The term *Rider* is applied to a deduction from any proposition of Euclid, because the deduction is borne up or supported by the mathematical reasoning worked out in the proposition, as a horseman, or *rider*, is supported or carried by the horse that he bestrides ; or, in other words, that the proposition carries the deduction on top of it, as it were, as the horse carries its rider.

10. MAYFLOWER.—Rule for Cube Root :—

(1) Divide the number into periods, by marking off every three figures, beginning with the unit's place. The number of periods will denote the number of figures in the root.

(2) The first figure of the root is the figure whose cube is the greatest cube in the first period. Subtract this cube from the first period, and bring down the next period.

(3) Multiply the square of the root already found by 300 to form a divisor, and from this determine the next figure in the root. (As the real divisor will be larger than this divisor, allowance must be made for this in determining the next figure.)

(4) The real divisor will be the sum of the following :—
- (*a*) The divisor already given.
- (*b*) The continued product of the root already found, the last figure in the root, and 30.
- (*c*) The square of the last figure in the root.

(5) Multiply this divisor by the last figure in the root, and subtract the product from the dividend, and bring down the next period.

(6) Form a divisor and find another figure in the root by exactly the same process, continuing the operation until all the periods are exhausted.

Note.—In decimals the periods are marked to the right, and if there are not sufficient figures to complete periods, ciphers must be added.

If there be a remainder, then the given number has no exact cube root, but an approximation can be carried to any degree of nearness by adding ciphers, and finding any number of decimal places.

Example :—Find the cube root of 11543·176.

```
                    11'543·176(22·6
                       8
                    ------------
2² × 300 = 1200  |  3543
2 × 2 × 30 =  120|
2²  =           4|
    ------------ |
         1324    |  2648
                 |
22² × 300 = 145200| 895176
22 × 6 × 30 =  3960|
6²  =            36|
    ------------ |
        149196   | 895176
```

11. BEACHY HEAD.—Parse and analyse, 'What boy has not learned his lesson that I gave him yesterday ?'

What—interrog. pro., used as an adj., qual. *boy*.
boy—com. noun, mas., sing., 3rd., nom. to *has learned*.
has—aux. verb to *learned*, indicating perfect tense.
not—adv. of mood (negation), modifying *has learned*.
learned—past part. of *to learn*, refg. to *lesson*.
has learned—reg. trans. verb, act., ind., perfect, 3rd, sing., agreeing with *boy*.
that—rel. pro., neut., sing., 3rd, obj., gov. by *gave*.
I—per. pro., com., sing., 1st, nom. to *gave*.
gave—irreg. trans. verb, act., ind., past, 1st, sing., agreeing with its nom. *I*.
him—per. pro., mas., 3rd, sing., obj., gov. by *to* understood.
yesterday—adv. of time, modifying *gave*.

Sentence.	Kind of Sent.	Subject.	Predicate.	Object.	Extension.
(*a*) What boy has not learned his lesson	Prin. Sent.	What boy	has learned	his lesson	not (negation)
(*b*) That I gave him yesterday	Adj. to *lesson* in *a*	I	gave	that (dir.) him (ind.)	yesterday (time)

12. RUSTICUS.—The solution of your query appeared in our issue for June, 1883.

13. TANGENT.—Show how to find $\tan \frac{A}{2}$ when tan A is given.

$$\text{Tan A} = \frac{2 \tan \frac{A}{2}}{1 - \tan^2 \frac{A}{2}}$$

$$\tan A \left(1 - \tan^2 \frac{A}{2}\right) = 2 \tan \frac{A}{2}$$

$$\tan^2 \frac{A}{2} + \frac{2 \tan \frac{A}{2}}{\tan A} = 1$$

$$\tan^2 \frac{A}{2} + \frac{2 \tan \frac{A}{2}}{\tan A} + \left(\frac{1}{\tan A}\right)^2 = 1 + \frac{1}{\tan^2 A}$$

$$= \frac{\tan^2 A + 1}{\tan^2 A}$$

$$\tan \frac{A}{2} + \frac{1}{\tan A} = \frac{\pm \sqrt{\tan^2 A + 1}}{\tan A}$$

$$\therefore \tan \frac{A}{2} = \frac{\pm \sqrt{\tan^2 A + 1} - 1}{\tan A}.$$

14. AOLIS NEP will find instruction on taking up ladder in any good book on stocking-knitting. Miss. Jones's manual of *Plain Needlework and Cutting-out* will be published in a few days (Hughes).

15. C. B. ELLISON'S writing is good, and of the right kind. With such command of the pen he should strive after uniformity. With better 'capitals,' fully eighty-five per cent.

16. C. RIDGE'S question is difficult ; there are so many text-books on geography. Langler's is good summary. Clyde's is fuller and descriptive.

17. A CONSTANT READER will find his qualification under Art. 50 (Old Code, Art. 79) of no value in the Colonies. Indeed, an English certificate does not, in most cases, exempt from examination by the Boards of Education in the Colonies.

18. HOREB might obtain seventy per cent., and easily add ten or fifteen more if he would study his capitals.

19. INQUIRER.—You will find the solution of your query in our issue for February, 1882.

20. J. HENTON.—This correspondent has kindly sent the following difficult question, which was given to Std. V. in a recent examination :—

	Hhd.	bar.	kil.	fir.	gals.
From	1	0	0	0	0
Take		1	0	1	2
					7

The difficulty arises from the fact that 3 kilderkins = 1 hogshead, and 2 kilderkins = 1 barrel, and therefore the question is:—From 3 kilderkins take 2 kilderkins 1 fir. 2 gals., and the answer is 7 gals.

21. H. T.—Your problem resolves into a cubic equation, which has no exact roots. One number lies between 81 and 82, and the other between 18 and 19.

22. CORRESPONDENT.—You will obtain the correct *signs* by the following method:—

$$\begin{aligned}(a-b-c)^2 &= \{(a-b)-c\}^2\\ &= (a-b)^2 - 2(a-b)c + c^2\\ &= a^2 - 2ab + b^2 - 2ac + 2bc + c^2\\ &= a^2 + b^2 + c^2 - 2ab - 2ac + 2bc.\end{aligned}$$

$$\begin{aligned}(a-b-c)^3 &= \{(a-b)-c\}^3\\ &= (a-b)^3 - 3(a-b)^2 c + 3(a-b)c^2 - c^3\\ &= a^3 - 3a^2b + 3ab^2 - b^3 - 3(a^2 - 2ab + b^2)c\\ &\quad + 3ac^2 - 3bc^2 - c^3\\ &= a^3 - 3a^2b + 3ab^2 - b^3 - 3a^2c + 6abc - 3b^2c\\ &\quad + 3ac^2 - 3bc^2 - c^3\\ &= a^3 - b^3 - c^3 - 3a^2(b+c) + 3b^2(a-c)\\ &\quad + 3c^2(a-b) + 6abc.\end{aligned}$$

23. INCOGNITO.—We do not reply to anonymous queries.

24. CLARIBEL will find the '*darning*' required in Standards V., VI., and VII. specified in the Third Schedule of the Code. She will be careful to note that some parts of the work are optional. See reply o Aolis Nep.

25. SEMPER FIDELIS.—Very good writing. Full marks if the looped letters were uniform.

26. DELTA.—*Skeats'* 'Etymological Dictionary' will be useful. 'Mrs. Shimmelpenninck's Life' is reported 'out of print.'

27. A SUBSCRIBER will find several 'Notes of Lessons' for infants advertised. *Singleton's* (pub. by Jarrold) is suggestive.

28. JOHN STUART must obtain permission of the Education Department to enter the Civil Service. He may have to repay some part of the cost of his training.

29. PRO BONO PUBLICO must improve in his writing. The syllabus for 'Scholarship' is implied in Schedule V. Last year's questions have been published.

30. HOPEFUL is bound to complete his apprenticeship under the prescribed conditions. He cannot 'skip a year.' Writing too uneven to gain more than 70 per cent.

31. A PUPIL TEACHER'S writing lacks firmness, and his text-hand and capitals must be *studied* to secure right proportions—and more than 65 per cent.

32. J. P. RADCLIFFE.—*Findlater's* or *Huxley's* 'Physiography.'

33. IDES.—Possibly; but the questions in geography may range over 'The World.'

34. H.—Purchase *Mulhauser's* 'Method of Teaching Writing.'

35. S. MADDOCKS.—The second specimen of writing is the better, because more uniform, and would gain at least 80 per cent. One translation is given this month. It is nearly literal; for, from the incorrect copying, you are evidently a beginner.

36. EDGAR QUINET.—The poems of the Troubadours. If we desire to form a correct idea of the effect which these poems could produce we must picture to ourselves the solemn assembly at the fêtes (festivals) which accompanied them. During the six months of winter the feudal castle had remained enveloped in clouds. No tournaments, no war; few strangers and (few) pilgrims; long, monotonous days, and sad, interminable (long, weary) evenings, poorly filled up by the game of chess. At length spring-time had arrived; the lady (of the feudal chief) had gathered the first violet in the orchard. With the swallows was expected the return of the Troubadour. On some fine day in the month of May he sent his singers and jugglers to recite his old romances to the burgesses and common people in the interior of the small towns; but he himself pursues the steep slope which leads to the castle. Without delay, from the (very first) evening of his arrival, the barons, esquires, and ladies assemble in the great paved hall to hear the poem which he has (just) completed during the winter. The Troubadour, in the midst of the assembly, does not read; he recites. But when his recital becomes elevated, he sings at intervals, accompanying himself on the harp or viol. His introduction is full of pride and ingenuousness. At the same time, it is a picture of the assembly.

'Sirs, now, make silence, knights and barons,
Kings and dukes, counts and princes of renown,
Prelates and burgesses, people of religion,
Matrons and maidens, and little children.'

37. TROUBLESOME.—*Bacon's* 'Essays,' by Lewis, Vol. I.; 'Political Economy,' by *Mrs. Fawcett*; the 'Royal History of Scotland,' published by Nelson.

38. EX-P.-T.—*Clyde's* 'Geography'; *Mansford's* or *Fitch's* 'Arithmetic.' We know of no book consisting *wholly* of examples of analysis.

39. T. E. M. TEACHER cannot write text-hand with regularity; but the small-hand is good.

40. ODYSSEUS.—We have not yet seen a separate edition of Book IX.

41. SEPOY will find *Whittier's* poem on the relief of Lucknow ('The Pipes,' etc.) in several collections. We last met with it in Isbister's 'Fourth Standard.'

42. WAT TYLER.—Mr. Winch holds four Advanced Science Certificates, and "D" (Full Drawing Certificate).

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Article 106 (*b*)

Merit Grant in Infant Schools.

BY MRS. MORTIMER,

Lecturer on Kinder-garten at the Home and Colonial Training College, London.

LESSON—RICE.

CLASS—CHILDREN OVER SIX.

Apparatus:—Some rice and corn (wheat and barley); picture of rice plant; ears of wheat and barley.

I. *Description.*—Some rice should be shown to the children, and they should be asked to describe it. It consists of a number of little pieces. What do you call these little pieces? What have you seen before that is made up of little grains. What is the difference between the grains of rice and the grains of sugar? Tell me some other things in little grains. Wheat, oats, barley, etc.

Let us look at one of these grains of rice. What can you tell me about it? It is white and very hard, and of an oval shape. What else do you know that is of an oval shape? An egg. The children should then repeat, 'A grain of rice is white, hard, and oval in shape.'

II. *Whence obtained.*—We get rice from a plant called the rice plant. See, here is a picture of it. Have you ever seen a plant anything like this? Yes, it is very much like the corn plant. Who can tell me which corn plant it is like? It is something like barley. Do you know how barley differs from wheat and oats? The seed part or the ears are covered with long hair-like pieces. Yes, we call that the *beard*, and I daresay you have heard people speaking about *bearded* barley. The teacher, then directing the attention of the children to the picture of the plant, should point out the arrangement of the ear. The seeds are contained in it. The ear grows out of the stem. The children should have specimens of the ear and stalk of the corn plants shown them. The children's attention should next be directed to the stem, and a comparison should be made with some familiar object about as high as the rice plant. The children should then repeat, 'The rice plant grows to a height of six feet.' The teacher would have to tell the children that the rice plant grows in very damp, muddy places. There are plenty of such places in England, but still, the rice plant will not grow here. This is because it wants something else to make it grow. It will only grow in very hot countries. In the parts where it grows the land is covered with water for

some time, then the water runs off the land; and what do you think the land is like? It is like mud. Yes, that is the best thing for the rice to grow in. There is one place where the rice seeds are thrown into the water. I suppose if you were to see people sowing seeds like this you would think they were very silly. When the water goes away the men go and look after the rice, and they find it has already begun to grow. When it has grown high, and the ears are ripe, they cut it down just in the same way as the corn is cut in our country. They use a knife, however, that is rather different. The long steel part is not sharp like those our farmers use, but is like a saw; that is, all cut into teeth.

The men have to cut the rice down very quickly, and get it away before the water comes back again. If the water were to come before it was cut down, it would be spoilt, and then you know it would not be any good.

Can you tell me which part of the rice plant we eat? Yes, the seeds. When you get wheat from the field, and are going to eat it, what do you first do? Pull off all the skins. These skins are called husks. Well, the rice seeds are covered with husks, and before we use the rice they have to be taken off. This is generally done before the rice is sent to England. The children should then repeat, 'We eat the seeds of the rice plant after the husks are taken off.'

III. *Uses.*—For what do we use rice? For eating. What must be done to it before you can eat it? It must be cooked, so as to make it soft. How is it cooked? Sometimes it is boiled, and sometimes it is made into puddings. What is put with the rice when it is made into puddings? Eggs, milk, and sugar.

Sometimes it is made into cakes. Do we use the same rice for puddings and cakes? No, the rice for cakes has been ground into a powder. What is it like then? It is like flour. Yes, and we call it 'ground' rice.

Of what do we make bread? Of flour. Can you tell me of what flour is made? Yes, wheat is ground, and then it is called flour, and this flour is made into bread. Well, in some countries people grind the rice into flour, and use it for making bread. I do not think you would like this bread; it is not so nice as the bread made of 'wheat' flour, and very soon gets very hard and dry. The children should then repeat, 'Some people use ground rice to make bread.' Do you know what your mother uses when she wants to make your collars and dresses stiff? She uses starch. A great deal of starch is made from rice. The children should then repeat, 'Rice is used for making starch.'

Do you remember the long stalks of the rice plant? Now these are very useful for making hats and bonnets. What kind of hats do we call these? Straw hats. These hats are quite white. Do you see this beautiful thin paper? It is called rice paper, and is so called because it is made from rice.

IV. *Summary.*—This should consist of very simple words, and should be written on the board as the lesson proceeds.

Rice is white and hard. It grows in hot, muddy places.

The plant is like our corn plants. Rice is used for food.

In some places it is made into bread. Starch and paper are made from rice.

LESSON—THE APPLE AND PEAR.

CLASS—CHILDREN UNDER SIX.

Apparatus:—Apple and pear; pictures of the apple and pear trees.

I. *Description.*—An apple should be placed before the children, and after they have named it, they should be asked to describe it. It is round and green. Are all apples green? No, some are red, some brown, some yellow. When are apples of these colours? When they are ripe. Feel this apple. What can you say about it? It is smooth, and rather hard. What do you call this part of the apple? The stalk. Of what use is it? The apple is joined to the tree by it. Do you know what this is called? Yes, it is the eye of the apple. Now see what I have done. Cut the apple in half. What can you say of this? It is the inside of the apple. Is it green like the outside? No, it is of a very pale yellow. That is right; some apples are quite white inside. What part is green? The skin. Where is the skin? On the outside of the apple. Do you notice any other difference between the inside and outside of the apple? Yes, the outside is dry, and the inside is wet. What makes the inside wet? The juice.

Now I want you to look quite in the middle of this half of the apple. Do you know what there is there? Yes, some pieces of skin, and some pips. What do we call this part of the apple? The core. What are the pips like? They are like seeds. What colour are they? They are dark brown. Yes, they are the seeds, and when they are brown, the apples are ripe. You have all tasted apples. Can you tell me what kind of taste they have? A nice sweet taste. Always? No, sometimes they taste sour. When is this? When they are not ripe. There are some apples that are never sweet, not even when they are ripe. They are called cooking apples.

The children should then be asked to name the different parts of an apple. The skin, the stalk, the eye, the inside, the juice, the core, and the pips.

The teacher should now show a pear to the children, and ask them to name it. What can you say about the pear if you compare it with the apple? It is not as round as the apple is; it is longer, and comes to a point. Which end comes to a point? The end where the stalk is. What is at the thick end of the pear? The eye. What colour is it? Brown; some are green and some yellow. What had the apple on the outside? A skin. Well, if I cut this pear, you will see that it also has a skin. What difference do you notice about the inside? It is much softer than the apple. The children should then repeat, 'The inside of the pear is softer than that of the apple, and is more juicy.'

What did we find in the centre of the apple? The core. Now look at the pear; is there a core in it? Yes, and there are pips there, but they are quite black. Do the apple and pear taste the same? No, they both have a sweet taste, but they are very different.

II. *Whence obtained.*—From where do we get apples and pears? From trees in the garden. Do you know what kind of trees they are? They are generally large trees, though you will often see small ones with very nice fruit on them. What time of the year do we get apples and pears? If you were to watch an apple-tree you would see that all the winter-time the tree was quite bare and looked as if it were dead. Then when the weather begins to get warm, a great many pretty flowers are seen all over the tree, and at the same time green leaves are beginning to come. Then you would see that when these flowers fade away very small apples have come. These get larger and larger, and the green leaves also get large. Then when summer comes, and the nice warm weather, these apples get ripe, and instead of being green they become red, brown, etc. Sometimes the wind blows the apples off the tree and we are able to pick them up. It would not do for us to wait for the wind to blow all the apples and pears off the trees, for when they fall they get knocked and soon go bad. Men have to pick them. They get ladders and put against the thick branches, and pick the apples off, and put them in baskets. When they are picked like this they keep a long time. Sometimes there are a great many trees, and the men either shake the apples off, or use long sticks and beat the trees, and this knocks all the apples down. Women and children then pick them up and put them in baskets.

When there are a great many trees in a garden we call it an orchard.

III. *Uses.*—For what do we use apples? For eating. What else? They are put into puddings and pies. Sometimes they are made into jam and jelly. Pears are also used for eating. Do we make puddings and pies of pears? Not in this country.

IV. *Summary.*—An apple is round, and of different colours. The parts of the apple and pear are—the stalk, the eye, the skin, the inside, the juice, the core, and the pips. They grow on trees. They are used for eating. Apples are made into puddings, pies, and jelly.

LESSON—LEATHER.

CLASS—CHILDREN OVER SIX.

Apparatus:—Some pieces of leather and skin, a slate, duster, some water.

I. *Qualities.*—Some leather should be shown to the children, and they should be asked to say what they can about it; by looking at it they will see that it is of a brown colour. The teacher, bending a piece of leather, should ask, What am I doing? Bending the leather. Tell me some other things that you can bend? What do we say of all these things? They are flexible. The children should now repeat, 'Leather is flexible.'

Now, Mary, I want you to come and hold this piece of leather in one hand, and this slate in the other. You see they are both about the same size, but what can you tell me about the weight? The slate is heavier than the leather. We say leather is light. The children should repeat this. What have I in my hand now? A duster. What am I doing? Pouring some water on it. What do you notice about that water? It has gone through the duster; there is no water left on the top of it, where it was all poured. Watch again. What am I doing now? Pouring some water on the leather. What do you notice this time? The water is still on the leather; it does not run through. Tell me some other things that will not let water through? Slate, china, glass, etc. What do we say of these things? They are waterproof. The children should then repeat, 'Leather is waterproof.'

For what do we use leather? For making boots and shoes. Yes, this is one of the great uses of leather. Why do we not use calico, cloth, or even felt for our boots? Yes, they would very soon wear into holes. Because leather lasts a long time we say it is durable. Why do we say leather is durable?

II. *Uses.*—You have already told me one use of leather. What is it? For making boots and shoes. Can you tell me anything else that is made of leather? Bags, straps, harness, gloves, aprons, etc. You see leather is used for making a great many things. We say it is very useful. Can you tell me why it is so useful for making boots and shoes? Let us read from the blackboard all we found out about leather, and then think which of these qualities make it useful for making boots. The first quality is flexible. What does that mean? Do we need leather to be flexible in order to make boots of it? Yes, it is very much better to have something that will bend than anything quite stiff. When we move our feet, our boots bend a little, too; this makes them comfortable, and keeps them from hurting our feet: sometimes your boots hurt your feet, but that is when you have made them very wet, and then dried them too quickly. What does this do to your boots? Makes them very hard and stiff. What must you do to your boots to make them soft again? Grease them. Yes, then they become flexible again, and do not hurt you when you wear them. Now, what is the next quality? Light. Do we like our boots light? Why do we not like boots made of something heavy? They would make us very tired. The next quality is waterproof. What does that mean? Do we need our boots to be waterproof? Why? Because we sometimes have to go out in the rain, and our feet would get wet if our boots were not waterproof. Sometimes your boots do let the water through. When is that? When they are wearing out. What has to be done to them then? They have to be mended, or else we must have new ones.

Now, there is still one more quality that makes leather so useful for boots. What is that? It is durable. What does this mean? The children should now repeat, 'Leather is useful for making boots and shoes, because it is flexible, waterproof, light, and durable.'

III. *Whence obtained.*—Can any one tell me where we get leather? Well, I will tell you; it is made from the skins of different animals. You can tell me some—the horse, cow, goat, etc. The children should now repeat, 'Leather is made from the skins of animals.'

Now, I want you for a moment to look at your own skin: touch the skin of your hands, and of your face. If you run fast in the summer-time, how do you feel? Very hot. What do you sometimes see on your face and hands when you are very hot? Little drops of water. What do we call this? Perspiration. Where does it come from? From under the skin. How does it get outside the skin? It comes through. Yes, there are very little holes in the skin called pores, and it is through these that the perspiration comes. All animals' skin is full of these little pores like yours. I told you leather is made from skins—What is the difference between the skin and the leather? The skin lets water through—it is porous; and the leather will not let water through—it is waterproof. Would you like the skin to be made into boots? Why not? Something has to be done to the skins to make them waterproof before they are made into leather.

IV. *Summary.*—This should be written on the blackboard as the lesson proceeds:—

Leather is of a brown colour; it is flexible, light, waterproof, and durable.

Leather is used for making boots and shoes, bags, straps, harness, aprons, etc.

Leather is made from the skins of animals.

LESSON—THE SWALLOW.

CLASS—CHILDREN OVER SIX.

Apparatus:—Stuffed specimen of swallow; picture of several other birds for comparison.

I. *Description.*—The stuffed specimen of the swallow and the above-mentioned picture should be placed before the children so that the description of the swallow can be obtained by comparison. What kind of body has the swallow? It has a long slender body. With what is it covered? Feathers. If you feel these feathers, what can you say of them? They feel soft, smooth, and thick. What do you mean by saying they feel thick? Feel this one; does that feel thick? Oh, no. Well then? The feathers are close together, and there are a great many of them, and that makes them feel thick. If you look at them, what would you say of them? They are of a grey colour. What do you say, Mary? Rather a dirty-grey. And you, Harry? Yes; the feathers are of a bluish-grey. What else do you see? The top of the head is of a reddish-brown and the tail is black. Now look again at the feathers; what else can you tell me? They are glossy. What can you tell me about the swallow's tail? It is very broad and divided. Yes; because it is thus divided we say the swallow's tail is forked. Now look how wide it can open its mouth. What can you say of its legs? They are short and very thin. What do you see on its toes? Claws. What can you tell me about them? They are long and curved.

II. *Habits and Food.*—Where do you generally see swallows? Flying about in the air. Yes; it is getting its food while it is doing this. What do you think it is able to find in the air? Flies. Yes, and other small insects. The children should then repeat, 'The swallow lives on flies and other small insects.'

The teacher might here point out to the children that in fine weather the insects fly high in the air and the swallows do the same. In damp weather the insects come lower down, and you will see the swallows flying close to the ground. So you see if you watch the swallow you will be able to tell what kind of weather we are going to have. When does the swallow fly high in the air? For what does it do this? Why does the swallow fly close to the ground in damp weather? What part of the swallow enables it to fly so well and for so long a time? Its long, strong wings. You remember you told me that it had a very wide mouth, and if you look at the swallow

when it is flying you will see that its mouth is open; and its mouth is sticky, and the flies are thus easily caught. What kind of legs did you say the swallow had? Short and slender ones. Why does it not have strong legs? Because it does not need them. That is right; the swallow does not stand to get its food. Tell me a bird that stands to eat its food? The sparrow, robin. And now a large one? A hen.

You have told me that the swallow lives on insects and flies, which it catches in the air. Are these things always to be found in the air? When are they there? In the warm weather. Yes; when do we have warm weather? In the summer. What kind of weather do we have in the winter? Cold weather. Do you see the insects and flies in the winter? What do the swallows do then for food? If you look about you, you will notice that you never see swallows in the winter-time. Where do they go? Well, I will tell you. As soon as the weather begins to get cold, these birds fly away from us and go to a warmer country. You know that in our country the weather is cold in winter, but there are some countries where the weather is warm then. What do the swallows do? They fly away to warmer countries. When do they do this? When our winter is coming. And when do they come back to us? When the warm weather is coming again. Do you not think it is very wonderful that these little birds find their way back to us from countries such a long way off beyond the wide sea? And you must remember that they not only come back to the same country, but to the same place where they left their nest; and should they find the nest gone they seem to be very sorry and in great trouble. I hope you will not be unkind when you see a swallow's nest and knock it down. Would you like to know something about the swallow's nest? It is generally made of mud or clay, something the shape of a cup, and it is lined inside with soft grass, feathers, wool, and other things. Why does the swallow put these soft things inside its nest? To make it soft and warm. Why does it want it soft and warm? It lays its eggs in the nest, and sits on them and keeps them warm until the little birds come out of the shell. These little birds have hardly any feathers and cannot fly; so you see they want a nice warm house to live in. When these young birds grow up they will then make nests for themselves. (It would be well for the teacher to have a good model of a nest.) Have you ever seen a swallow's nest? Where did you see it? Under the roof of a house. Yes, the swallow likes to build its nest there. Sometimes the swallow builds its nest in the chimney. Why does not the nest get smoked? Because in the warm weather we do not have fires in the grate, and therefore there is no smoke to go through the chimney.

III. *Summary.*—This should be written on the blackboard as the lesson proceeds, and should afterwards be copied by the children or written from memory.

The swallow has a long slender body, which is covered with thick, soft, smooth, glossy feathers.

Its wings are very long and strong.

Its tail is broad and forked, and of a black colour.

It has a wide mouth covered with something sticky.

Its claws are long and curved.

The swallow lives on insects and small flies, which it catches while flying.

LESSON—SPONGE.

CLASS—CHILDREN OVER SIX.

Apparatus:—Piece of sponge; basin of water; a piece of wood.

I. *Qualities.*—A piece of sponge to be placed before the children, who should be asked what it is. What can you tell me about the sponge? It is of a brown colour; it is full of little holes. Do you know what we call these little holes? Yes, they are called pores. Can you tell me anything else that is full of pores? What do we say of all these things? They are porous. The children should repeat, 'Sponge is porous.'

Now tell me what I have done. Put the sponge into some water. When I lift the sponge out of the basin, what do you notice? The basin is empty. Where is the water?' In the sponge. What does the sponge do when you put it into the water? Soaks it up. Name some other things that will soak up water? Blotting-paper, flannel, bread, etc. What do we say of all these things because they soak up water? They are absorbent. The class should now repeat, 'Sponge is absorbent.'

Now, when I squeeze the sponge, what happens? The water runs out into the basin again. Mary, will you come here and feel this sponge? Now put it into the water again. Now take it and hold it up. What difference do you notice? It is much heavier. What makes it so heavy? The water it has soaked up. How does the sponge feel? Soft. Does it always feel soft like this? No, if you let the sponge get dry, it gets hard, but you can very soon make it soft again. Do you know how? Yes, by putting it in some water.

What have I in my hand? A piece of sponge. And in this hand? A piece of wood. You see they are both the same size? The teacher taking up the sponge, and squeezing it in her hand, says, What can you tell me about the size of the sponge now? It is very much smaller. The teacher taking up the wood, and squeezing it in her hand, says, What am I doing now? Squeezing the wood. What can you say about the size of it? It is not altered. You cannot make it small like you can sponge. Now look at the sponge again. What happens directly I open my hand? The sponge springs back to its large size again. Do you know anything else like this? What is this? Elastic. What have I done to it? Stretched it. When I leave go what happens? It returns to its place. You see that is like the sponge, only you press the sponge, and you stretch the elastic; but in what are they alike? Directly you leave them go they return to their proper size again. Do you know what we say of those things that are like sponge? We say they are elastic. The children should now repeat, 'Sponge is elastic.'

II. *Uses.*—Now, children, for what do we use sponge? For washing ourselves. Why do we like sponge to wash with? Because it is so soft, and takes up a lot of water. Have you ever seen sponge used for anything else? Yes, you may sometimes see men cleaning cabs, carts, and carriages with sponge, and your mother also uses it to clean windows. Is this sponge like that we use to wash ourselves with? No, it is not so soft, and it is coarse; you would not like to use it for washing your face.

III. *Where found.*—Children to be asked if they know where sponge is found. If they do not know, tell them it is found in the sea, growing on rocks and plants. Men go into the sea and pick the sponge from the rocks. Would you like to go under the water to get the sponge? No, if you were to try to do it, you would be drowned. The men who go down have something on them, so that they can breathe under the water. They are called divers. They do not stop under the water long. They go down and come up very quickly again with some sponge; then they go down again for some more.

IV. *Summary.*—This should be written on the blackboard as the lesson proceeds:—

Sponge is of a brown colour; it is porous, absorbent, soft, and elastic.

Sponge is useful for washing ourselves; it is also used to wash windows, cabs, carriages, etc.

Sponge is found in the sea.

LESSON—HOW CHILDREN MAY BE USEFUL.

CLASS—THE BABIES.

Now, children, I want you to think about what you do all day, and then we will try and find out in how many ways you can help your mother. What are you doing all night? We are sleeping. Can you do anything to help your mother then? No. When do you wake up? In the morning. There is a little boy who says he woke

up in the night. Do you always wake up in the night? No, only sometimes. Now, there is something you can do to help your mother directly you wake up in the morning. Cannot you tell me? Some little children wake up very early, long before their mothers and fathers. These little boys and girls begin to play, and call out very loudly, and make such a great noise, that they wake their parents, who want to sleep. Can you tell me why they want to sleep? Because they are tired. Why are your mother and father so tired? Because they have to work so hard. So you see you ought not to wake them. Then the noise often wakes up the little baby, and then what does your mother have to do? Get up and nurse it until it goes to sleep again. Tell me, then, how you can help your mother in the morning when you first wake up? Yes, that is right; you must lie quite still, and not make any noise until your mother tells you it is time to get up. Then she will think you are very good for being so quiet. The children should then repeat, 'We help our mother when we lie still, and do not make any noise.'

When your mother says 'Get up,' what will you do? Jump out of bed directly, and try to dress ourselves. There are some little boys, and girls too, who do not get up directly they are told. Some like to sleep a little longer, and some like to play in bed instead of getting up. Well, their mother calls them once, then she has to come again, and sometimes again and again before these little boys get up. What does your mother have to do in the morning? Light the fire and get the breakfast ready. Well, you see she has plenty to do, and yet some little children will make her leave off her work several times to call them to get up. Is that the way to help their mother? No, it makes her work much harder. Who can tell me how you could help her instead of giving her more work to do? By getting up directly mother tells us, and trying to dress ourselves. Yes, some of you can quite dress yourselves, but some can only put some of your clothes on. Those who cannot dress themselves should let their brother or sister dress them. The children should then repeat, 'We can help our mother by getting out of bed directly she calls us, and getting ourselves dressed.'

When you are dressed you can do ever so many things to help your mother. First, you must remember that you always help most if you do what you are told at once, and do not want your mother to tell you to do the same thing over and over again. Then, perhaps your mother may want something that is upstairs. What can you do? We can run and fetch it for her.

When your mother is so busy she cannot very well look after baby, can you tell me how you can help her? We can play with baby and make it laugh, and baby likes this and will not cry. What does your mother have to do when baby cries? She has to nurse it. The children should then repeat, 'We help our mother when we play with the baby and keep it from crying.'

Now, when your mothers get you ready for school, they make you clean and put on clean pinafores, and try to make you look nice and tidy. Sometimes when little boys and girls are ready for school, they go into the garden or into the street and make themselves very dirty. What do their mothers have to do then? Make them clean again. Is that helping their mothers? No; their mothers have to do all the work over again. And what must they do with the dirty pinafores? They have to wash them. Now tell me then how you can help your mothers? By keeping ourselves clean when we are waiting to go to school. The children should then repeat, 'We help our mothers by keeping ourselves clean.'

Can you always keep yourselves clean? You cannot help getting dirty sometimes, and your mothers are not cross with you then. After you have been in school all day and have been playing, they expect to find you want washing and that your pinafores are dirty. It is only when you do something that you ought not to do and so get dirty, that your mothers are cross with you.

I dare say you will be able to do a great many other things to help your mothers when you are at home, but you must remember that you never help your mother if you are cross with one another, because that only makes her feel unhappy. Really the best way for little children to be useful, is for them to play with one another quietly, and to do what they are told directly.

LESSON—BEES.

CLASS—CHILDREN OVER SIX.

Apparatus:—Specimens of bees; large drawings showing the structure; some honeycomb, wax.

I. *Description.*—The specimens and drawings should be shown to the children, who would then readily recognise that the bee is divided into three parts, viz.: The head, the chest, and the abdomen or stomach. The children should then be exercised in pointing out the different parts.

Now look at the head of the bee; what can you see there? Two large eyes and something sticking out near its mouth. Yes, this is called its trunk. What animal do you know that has a trunk? The elephant. Yes, but there is a little insect you see flying about the window in the warm weather that has a trunk; what is its name? The fly. Yes, if you look at a fly on a piece of sugar, you will see that it stretches or puts out its trunk to the sugar. For what does it do this? To eat the sugar. Yes, and the bee uses its trunk just in the same way. Look at the body of the bee, and tell me what you notice. A great number of short hairs. How many legs has the bee? It has six. Now look very carefully at the back one and you will see there is a smooth hollow with thick hairs round it. This is called the basket. For what do you use baskets? Well, the bee uses it to carry the dust in. This dust is obtained from the flowers and forms the wax. Now look at the back part of the bee. Can you tell me anything about it? Yes, it has a sting there. What must you do when you see a bee? Keep out of its way, and not play with it. Why? Because it might sting you. Yes, and the sting of the bee is likely to make you very ill. Do you know why? Because it is poisonous. It is in this part of the bee that the honey is made.

II. *Habits.*—Who has ever seen a bee? What was it doing? Flying about from flower to flower. What does it do while on the flower? Yes, you see it puts its trunk right into the flower and gets something out. Do you know what that is? Yes, honey. Where does the bee take the honey? To its home. What do we call its home? The hive. See what I have here, do you know what it is? This is what the bees make to put the honey in. The young bees are also put in little spaces like these. We call each of these little spaces a cell. It is all called the honeycomb. Do you know of what it is made? Yes, of wax. This wax is the dust of the flowers. Do you remember the little basket on the bee's leg I showed you? This dust or pollen of the flower falls on the bee's body. He rubs it with his legs and it falls into the basket, and in this way he carries it home. Do you know why the bees want to put away the honey? They cannot get honey in the winter. So you see if they did not take care of some, they would have no food, and then what would happen to them? Why cannot they get honey in the winter? Because there are not many flowers, and it is too cold for the bees.

There are three kinds of bees in a hive—The queen, the working bee, and the drone.

The queen bee is the largest one and is the mother, and lays eggs from which the young bees come. The other bees wait on her and bring her food.

The working bees are small and do all the work. They are always very busy.

The drones are the lazy bees. They never do any work. Which should you try to be like, the working bee or the drone?

III. *Summary.*—This should be written on the board

as the lesson proceeds, and afterwards written from memory by the children.

The bee is divided into three parts—head, chest, and abdomen.

It has two large eyes and a trunk.

Its body is covered with short hairs, which catch the pollen.

It has six legs, three on each side, and on the hind one there is a hollow place called the basket.

Bees give us wax and honey, which they get from flowers.

There are three kinds of bees—the queen, the working bees, and the drones. They all live in the hive.

(To be continued.)

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Recent Inspection Questions.

[*The Editor respectfully solicits contributions—all of which will be regarded as* STRICTLY PRIVATE—*to this column. For obvious reasons, it cannot be stated in which district the questions have been set.*]

Arithmetic.

STANDARD I.—DICTATED.

(1)	(2)	(3)	(4)
507	36	504	617
68	714	297	319
9	80		
70	605	207	298
836	8		
1490	1443		

STANDARD II.—DICTATED.

(1)	(2)	(3)
801	6395	12)47344
109	395	
692	2526205	3945—4

STANDARD III.

(1) Divide nine hundred thousand and one by eighteen. Ans. 50,000—1.

(2) £567 18s. 6½d + £4920 6s. 10d. + £51,783 19s. 11¾d. + £2202 16s. 0¾d. + £2867 15s. 7½d.; (given in words.) Ans. £62,342 17s. 0d.

(3) How many score sheep are there in six and a half thousand? Ans. 325.

(4) A man paid 15s. 6d. out of his week's wage, and then had 2 half-crowns, 3 florins, and 5 sixpences left; find his week's wage. Ans. £1 9s.

STANDARD IV.

(1) Divide £59,366 15s. 6d. by 97.
Ans. £612 0s. 6¾d.,—45.

(2) Subtract 4s. 10½d. from £1069 10s., then bring the remainder to half pence. Ans. 513,243.

(3) Reduce 7 miles 1 yard to feet.
Ans. 36,963 feet.

(4) A certain house had 6 windows in it, every window had 12 panes of glass in it, and each pane contained 72 square inches. How many square feet were there in all the windows?
Ans 36 square feet.

STANDARD V.

(1) If 15 men's wages amount to £19 3s. 10d. in one week, how many men could I pay out of £287 17s. 6d. for one week at the same rate?
Ans. 225 men.

(2) $\frac{2}{5} + \frac{1}{4} + \frac{3}{10} - \frac{5}{6}$. Ans. $\frac{7}{60}$.

(3) What would 1 fur. 13 po. 5½ ft. cost at £108 per mile? Ans. £18.

(4) If 4800 cart-loads of coal are sent from a colliery, how much is it worth at 7s. 6d. a ton, each load containing 16 cwt.? Ans. £1440.

STANDARD VI.

(1) A lady spent $\frac{1}{5}$ of her money in one shop, $\frac{1}{8}$ in another, and had £6 15s. left. How much had she at first? Ans. £10.

(2) Subtract $\frac{1}{2} + \frac{3}{4} + \frac{3}{7} + \frac{5}{14}$ from $15\frac{1}{6} - 4\frac{1}{12}$.
Ans. $8\frac{25}{126}$.

(3) If a family of 18 persons spend £240 in 8 months, how much will a family of 48 persons spend in 16 months at the same rate?
Ans. £1280.

(4) If I lodge £360 in a bank, how long must I let it lie there at 3 per cent. to gain £37 16s.?
Ans. 3½ years.

STANDARD VII.

(1) Find the cost of insuring a cargo worth £5000 at £3 13s. 4d. per cent. Ans. £183 6s. 8d.

(2) By selling a horse for 50 guineas a dealer gains 5 per cent. What did the horse cost him?
Ans. £50.

(3) Find the discount on £564 paid 3½ years before due, at 5 per cent., simple interest.
Ans. £84.

(4) If the P. W. of a sum of money due 8 months hence at 5 per cent. be £250, what is the complete bill? Ans. £258 6s. 8d.

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Publications Received.

Adley (J.) and Co.—

The Elementary Singing Master on the Letter-Note Method. By D. Colville.
Letter-Note School Music. By D. Colville.
The Letter-Note Vocalist. Nos. 1 to 12.

Bell (G.) and Sons—

Code Standard English Grammar. Part IV. By C. P. Mason, B.A.
Italian Primer, with Exercises. By Rev. A. C. Claplin, M.A.
German Primer, with Exercises. By Rev. A. C. Claplin, M.A.

Blackie and Son—

Elementary Text Book of Physics. By J. D. Evereth, M.A., etc.
Principles of Agriculture. Book III.
Magnetism and Electricity. Part II.
Botany. Part III.
The Good-Natured Man. By Goldsmith.
Home Lesson Books. First and Second Historical Readers.
Simple Lessons in Flower Painting. Nos. 1, 2, 3, and 4. By Vere Foster.

Chambers (W. and R.)—

Elementary Science Reader. By C. McRae, M.A.
Select Poems. By Mrs. Hemans.
Milton's 'Comus.'
Campbell's Select Poems.

Gill (G.) and Sons—
Gill's New Music for the Code 1883. By R. H. McCartney. Parts I., II., and III.

Heywood (John)—
A Manual of Elementary Drill. By Ed. T. Hunt.
John Heywood's Home Lesson Book for Standard VII. By A. Gardiner.
Selections of Beautiful Poetry for Standards IV., V., and VI. By J. S. Horn.
The Child's Bible Expositor. By S. E. Scholes.

Isbister (W.), Limited—
The London Arithmetic Test Cards for Standards III., IV., V., and VI.

Johnstone, Hunter, and Co.—
The Stocking Knitter's Manual. By Mrs. G. Cupples.

Kegan Paul, Trench, and Co.—
Education and Educators. By David Kay, F.R.G.S.

Letts, Son, and Co.—
Letts's Illustrated Household Magazine. Part XII. February.

Longmans and Co.—
Longman's Magazine. No. 16. February.
Key to Manual of Short Methods in Arithmetic. By Rev. J. Hunter, M.A.
Sundry Attacks on Private Schools. By R. W. Hiley, M.A.

Murray (John)—
The Student's Hume. Parts I., II., and III.

Murby (T.)—
The Principles of Hygiene. By A. Carey, F.R.G.S.

Nelson (T.) and Sons—
The New Royal Readers for Standards I. and II.

Relfe Bros.—
Bookkeeping by Double Entry. By James Collier, B.A.

Simpkin, Marshall, and Co.—
Our Schools and Colleges. Vol. I., Boys; Vol. II., Girls. By Captain F. S. Dumaresq de Carteret-Bisson.

Smith, Elder, and Co.—
The Cornhill Magazine. No. 8, February.

Swan Sonnenschein and Co.—
Seeing and Thinking. By Schaible and Althaus.

Stanford (E.)—
Facts Around Us. By C. Lloyd Morgan, F.G.S.

The Wesleyan Methodist Sunday-School Union—
Luther Miller's Ambition. By L. Montfort.
Two Saxon Maidens. By Eliza Kerr.
Carols for Christmas Services.
The Promised Land. By T. Austin. (Sol-fa.)
The Promised Land. By T. Austin. (Staff.)

The National Society's Depository—
Sight Singing for Schools.

Unwin (T. Fisher)—
Industrial Curiosities. By A. A. Japp, LL.D.
Stops; or, How to Punctuate. By Paul Allardyce.

Ward, Lock, and Co.—
The Universal Instructor. Part XL. February.

Publications Reviewed.

The New Royal Readers. Standards I. and II. London: T. Nelson and Sons.

These new reading books have been issued with a view to meet the very latest requirements of the ever-changing Code.

The editors and publishers have, apparently, vied with each other to produce a series of readers of exceptional merit. Everything has been admirably done. New lessons, carefully graduated; new illustrations of rare artistic and educational value; faultless models of writing copies (white on black ground); and a series of 'helps' adequate enough to satisfy the most fastidious teacher or the dullest scholar, all combine to stamp these readers as amongs *the* very best yet issued. Happy the child who treads this 'New' royal road to learning.

The Student's Hume in Three Parts. Part I.—From the Earliest Period to the death of Richard III.; Part II.—Henry VII. to the Revolution; Part III.—From 1688 to the Treaty of Berlin. London: John Murray,

To criticise this well-known standard work would be a waste of time. We, therefore, simply call attention to this new, cheap, and convenient edition, in three volumes. Pupil-teachers and students in training are specially indebted to Mr. Murray for this timely issue.

Cornhill Magazine, February, 1884.

This excellent magazine maintains its high reputation. Mr. Payn's 'Literary Reminiscences' are delightful. They, alone, are well worth the modest sixpence, charged for this capital periodical.

Common Things and Elementary Science in the form of Object Lessons. By J. Hassell, A.K.C. London. Blackie and Son.

This is a most complete handbook of object lessons. The author has occupied not less than 384 pp., in which a very wide array of topics are subjected to very exhaustive treatment. Each of the hundred and fifty-three chapters allows of subdivision, in some cases into two, in other cases into at least a dozen separate lessons. These are well arranged, fully illustrated, and accompanied by valuable hints as to method. Every page in this book impresses the reader with the very thorough treatment the various topics have received. The vast accumulation of facts and the advanced character of some of the lessons will constitute a difficulty unless careful and judicious selection accompany its use. We would suggest that such topics as the consideration of the solar surface, with its spots and facula, and the theories based upon their various appearances, are beyond the range of elementary science as a class subject.

In placing the book in the hands of any teacher whom we might influence, we would say:—

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With these precautions we know of no better collection of lessons for use by young teachers.

Blackie's School Classics: Shakspere's 'Henry VIII.' with Notes. Blackie and Son.

Messrs Blackie here offer at a low price a well-printed edition of 'Henry VIII,' bound firmly in flexible covers. A special feature of the little volume is found in a genealogical and biographical prefix, which will greatly help the children, into whose hands it is put, to understand the the relations and actions of the characters. The Notes at the end are also useful, being sufficiently full, and on the whole clear. We fear, however, that the vocabulary employed in the notes will often be too extensive to make it safe to follow the advice of the preface, and give the children the book to study themselves. 'Aimed to prevent Papal encroachment' is language as difficult for many boys to comprehend as several of the poet's passages which are explained. Teachers intending to adopt a play of Shakspere should certainly see this edition.

French Course. First Year. By Hector Rey. London and Edinburgh: W. and R. Chambers.

We have pleasure in commending this little volume. Its simplicity in style and arrangement makes it a very suitable text-book for those beginning to study the language, and the connected and complete way in which the subject is treated will much assist the learner in acquiring a sure foundation for after-studies. The printing is excellent, and in other respects the book is well adapted for school use.

Chambers's Historical Readers. Junior English History for Standard IV. London and Edinburgh: W. and R. Chambers.

This reader gives a complete survey of English history from the first landing of Cæsar to the present day. Details are, of course, as a rule, omitted, but those important features which are enlarged upon are treated in a bright and interesting manner, which cannot fail to bring the book into favour among its users. The illustrations and maps are numerous and good, and the volume seems adapted in every way for the use of Standard IV.

The English Constitution and Government. By Sheldon Amos, M.A. London: Longmans.

The dedication of this volume to the Emperor of Japan tells us it was originally prepared for the Commissioners of his Imperial Majesty; and, no doubt, the public owe a good deal to this fact, for the lucidity and thoroughness of the work. The author, as perhaps the leading professor of this difficult subject in our midst, was no doubt appealed to, to assist these gentlemen in studying our nation and her customs, etc., for the benefit of their own people, who a few years ago began to make such important changes in their government, currency, and, in fact, manner of life. Had this book been prepared for Englishmen, or even English boys, we strongly expect the author would have taken for granted as already known, and therefore unnecessary for insertion, many things which we find clearly expressed here. Every one knows that to answer a question really well, we must assume perfect ignorance on the part of the questioner; and we feel confident that it is this assumption—nay, perhaps conviction—of ignorance on the part of these foreigners that has produced this really almost faultless work. Most mathematicians think that everybody understands the nature of the impossible problem of 'squaring a circle,' but we doubt if one out of ten could even tell us what the problem depends on, and not three times that number even what it is; so, too, most writers on constitutional history would, we believe, assume a knowledge of many things which are carefully explained in the book before us, and omit them as unnecessary. At the beginning of the volume there are careful definitions of such terms as 'constitution,' 'law,' 'executive,' and 'right,' which ought to be well studied, and at the conclusion there are some valuable appendices, giving entire translations of the 'Magna Charta,' 'Confirmatio cartarum,' etc., with copies of other well-known bulwarks of British freedom, but known to the masses in very little more than name. The index at the end is very valuable, being exceptionally full. Every schoolmaster ought to have a copy of the book, as he would find it an invaluable adjunct to every lesson he might give in the history of our country.

Longman's Magazine. February, 1884.

This is an exceptionally good number of this well-known magazine. Mr. W. Clark Russell continues his admirable sea story, entitled 'Jack's Courtship; a Sailor's Yarn of Love and Shipwreck.' Among the other contributors are Richard Jeffries, D. Christie Murray, the author of the 'Recreations of a Country Parson,' and Mrs. Oliphant. We strongly advise our readers to 'take in' this excellent monthly.

The Standard Author Readers. (Complete Series.) London: Griffith and Farran.

We are sure that teachers—and especially *infant* teachers—will thank the publishers of this excellent series of reading-books. It is without a doubt one of the best ever produced, either for elementary or secondary schools. The editor has been singularly successful in placing within reach of the young some of the purest gems of English literature. The paper, printing, illustrations, and binding are alike excellent. We trust that teachers, before finally selecting their reading-books, will send for a full prospectus of 'The Standard Author Readers' to Messrs. Griffith and Farran, whom we heartily congratulate on the publication of these admirable volumes.

An Explanatory Arithmetic. By G. Eastcott Spickernell. London: Simpkin, Marshall and Co.

The real *raison d'être* of this book is, we confess, somewhat hard to find. Few schoolmasters are satisfied with the text-books they use; hence the enormous multiplication of these elementary treatises. The author, however, promises us in his preface such an amount of explanation that a master will be scarcely required. If the end and aim of arithmetic were to enable a boy to pass an examination, and to perform the very few practical questions that may be brought before him in life, we dare say the book under question would answer the purpose. But our children go to school to be educated, and arithmetic is the one educational subject, above all others, that we expect to be given to them; and we very much fear that if any one were to try and learn the science of arithmetic from this little book he would neither go very far, nor be lured on to a deeper and more exhaustive view of the subject. Some of the rules are given without a word of explanation, as in the case of extracting the square and cube root; the author almost implies that the processes employed are not able to be understood without a knowledge of algebra. This, we contend, is not the case, as a picture or two of such a nature as the author himself has given us, to show the method of finding the side, area, or contents of a rectangular surface or solid, would explain them both immediately.

The examples are numerous, and seem well arranged; the answers being printed at the end of the book.

Johnston's Standard Wall-Map of the British Empire. London: A. Johnston.

We have pleasure in directing the attention of teachers to this excellent production, the importance of which for everyday educational purposes can hardly be over-estimated. We have here a series of twenty-eight maps, embracing all our colonial and foreign possessions, from the mile-long Helgoland to the immense expanses of India, Australia, and British North America—each map nicely coloured and showing as much detail as is compatible with clearness and efficacy in class work. There is probably no map—save that of our native isles—which can show a greater claim to be displayed on the walls of a British school than one of the British Empire, and the map now under consideration has so many good points that it only needs to be known to be properly appreciated. It is remarkably well brought up to date, and the only improvement we can suggest is that some means of comparing the relative sizes of the various parts of the world delineated should be given, either by simply stating the number of square miles under British rule in each map, or else by marking off a square, to represent the area, in the top right-hand corner of each compartment, the same scale being employed in each case.

Useful Trees. A series of six, mounted and coloured. London: A. Johnston.

This series comprises the Oak, the Elm, the Fir, the Beech, the Ash, and the Mahogany, and as the drawings are well done and effectively coloured, they will form very valuable adjuncts to the object lessons.

The size of each card is 21 inches by 26 inches, and on the back is printed a description of the tree represented. This is a good feature, and will save the teacher considerable trouble in research.

The Proper Psalms for Certain Days. With Notes by the Rev. J. J. Scott, M.A. London: National Society's Depository.

We have pleasure in recommending this little manual to the attention of those of our readers who desire to possess an interesting explanatory guide to the due understanding of this part of the Holy Scriptures. The book has evidently been prepared with great care, and the copious notes and remarks are thorough, without being too erudite. We may add that they were originally delivered and published as part of a course of Lectures to Pupil Teachers in the diocese of Manchester.

Shakspere's 'King Henry IV.' The Second Part. Prepared and annotated for school use by Charlotte M. Yonge. London: National Society's Depository.

Miss Yonge's undoubted power as a writer of good healthy English, exactly fitted for English children, is a guarantee that any work, such as the one now before us, which has been prepared by her for school use will afford little ground for complaint. Nor does this example of her work fall below the high standard we should naturally expect. For the notes are carefully adapted for youthful use, the book is printed in good legible type, and the Introduction and Summary of the play, with which the volume commences, are written in the interesting, effective style so characteristic of the author of 'The Heir of Redclyffe.'

Third Paragon Reader: Standard III. Manchester and London: John Heywood.

This reader upholds the high character of those of the same series which have preceded it. The subject-matter is interesting, and the language throughout seems well adapted to the capacities of the Standard for which it is intended. The pages are enlivened with some well chosen woodcuts, and the book has been carefully attended to in the matter of paper and binding.

The Parts of Speech. By William B. Irvine. Relfe Brothers.

This is a useful little book for young children, illustrated by numerous examples. Towards the end of the book the analysis of the simple sentence is given, and when the pupil has advanced to conjunctions the different subordinate clauses are explained in an easy and lucid manner. The manual is wonderfully printed, and, withal, very cheap.

Guide for the Pronunciation of the French Language. A Synopsis of Appropriate Instructions. By J. G. Rousseau, Professor of French at the Forest School, Walthamstow. London: Dulau and Co.

Although we do not believe in the possibility of an English person acquiring anything like a good pronunciation of French words from written instructions, we have pleasure in saying that the guide tabulated by M. Rousseau seems as practical as any we have come across, and in the absence of the *oral* instruction, which in our opinion is absolutely necessary, may perhaps be of as much assistance as such written instruction can be.

Woods and Forests. No. 2. London: W. Robinson.

This well got-up periodical is, we believe, the first which has ever been brought out weekly, at least in England, in connection with the 'tree-growing' interest. Whether there exists a sufficiently numerous *clientèle* to render a publication of this sort a success we have no means of judging, nor indeed is it in our province to do so. Suffice it to say, that the intrinsic merits of *Woods and Forests* deserve success, and the paper will, from the sound technical information contained in its columns on all matters connected with forestry and arboriculture, prove a weekly boon to those interested in such matters. The illustrations are well up to the mark.

ERRATA.—By inadvertence two errors occurred in Mr. Winch's 'My Scholarship Answers,' which appeared in our last month's issue. In the working of Question 2 in the Arithmetic Paper (page 631) the number of oranges has been taken as 350 instead of 250; and in Algebra, Question 7 (page 634), the factors of $x^2 - x - 12$ should be $(x-4)(x+3)$ instead of $(x-6)(x+5)$.

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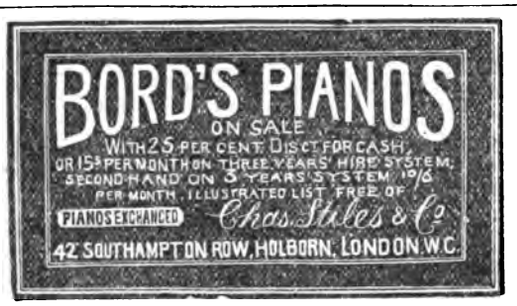
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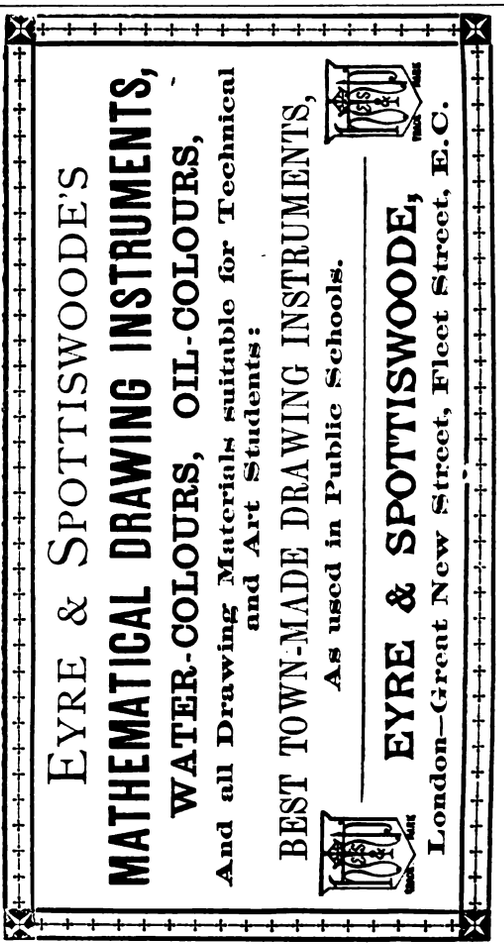
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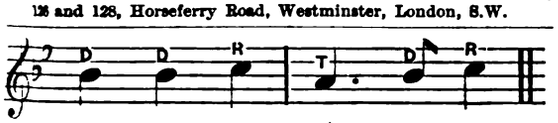

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However, early in the following year I began to suffer each morning from a high state of feverishness, which lasted many hours, and consumed my strength; upon movement my breath also became very short—and so short and rapid did it become that I can only describe the state of respiration to have been loud and hurried, the great rapidity causing the noise to be heard at a distance. Only as I remained perfectly free from movement did the above distressing effect subside, while a simple remove from my chair would at once beget the same unnatural action of every nerve and muscle. You will not wonder when I add I lost strength daily. Under these circumstances, the object, of course, of my physician was to subdue this singular state of respiration.

To attain this end I was constantly taking medicine and a variety of tonics, all of which only increased the fever, and rendered the breathing worse.

During the same year (1861) I saw several eminent London physicians, but they, with my own, were evidently quite in the dark as to the exact nature of the case. I derived no benefit whatever from their treatment; they could only say that it was not a lung affection, but one of the diaphragm.

Under the advice of my own physician I took a vapour bath, which injured me greatly, applied strong liniments, a blister and plasters, and, lastly, leeches to the top of my spine. The bleeding was not to continue for more than one hour; but, unfortunately, it was not foreseen that the very thing it was hoped it would remove was the means of preventing it from staying, and it was a day and a half before it quite ceased.

Very shortly after this I was quite laid aside, and could not move without help; constant retchings also commenced at this time. So I continued, alternately better and worse, when latterly I saw two homœopathic doctors, who said I had been both wrongly and roughly treated, and they believed it to be a case of Spinal Concussion and Irritation, and such cases, they need not tell me, were most intractable. I was not treated by either of the above, the one becoming afflicted, and the other not having confidence to make an attempt, again and again assuring my friends my case was hopeless.

But as results have since shown, my affliction, though a dark cloud, had yet a silver lining, to be discovered in due time.

In November last I heard of a remarkable cure by means of Electricity—a spinal and nervous case—the patient having been confined to her bed for eight years. This inspired me with hope with regard to myself. Soon after this your pamphlet on Magnetine was, in the providence of God, brought under my notice, and its practical remarks greatly interested me. I therefore wrote a statement of my case to you, and you very kindly replied, and advised me a Spine Band and Belt, saying mine was truly a case of spinal weakness, caused by a shock to the nervous system, and overstrain by overtaxation, aggravated by wrong medical treatment, and that the before-stated condition of the respiration was an effect of weakness and irritation of the spine induced by concussion of the same. As in this there was no fear of my being tampered with, and as you led me to hope I might be relieved, I procured a Spine Band, and wore it as directed. After some little time, and when making my usual attempt to discover whether any change were effected or not, I found to my great joy the hurried breathing subdued. However, having had so many disappointments, I thought it best not to be too sanguine, and await the next morning, when I still found no return; and with deepest gratitude do I now affirm that up to this present time no signs of all those untoward symptoms have again made their appearance.

By degrees, and with the additional aid of the Belt, I have gradually and wonderfully progressed; from sitting up for a short time I can sit up the whole day, and have done so for five weeks. I was able to walk alone very soon after wearing the Belt, and can walk slowly and gently up and downstairs. I have also taken a drive without any ill results; which was a great test, considering the distress and suffering which arose on two, and the only occasions during eleven years, when I was compelled to make a change of residence, and therefore be removed.

Allow me, therefore, my dear sir, to congratulate you most warmly upon your successful effort to render Magnetism portable, so great a desideratum, causing the wanting measure of life-current to pass unobtrusively into the system, weakness thus giving place to strength, sickness to health. If you think well, I shall be glad for you to make this a public testimony to the worth of Magnetine, reserving my address, which may be forwarded by you to any one wishing for a private communication with myself upon the subject.—I remain, my dear sir, yours truly and gratefully,

ELEANOR M. JONES.

To F. W. Darlow, Esq.

POSTSCRIPT.—It is a pleasure to me to be able to add, my health has been maintained up to the present time, and I can go about like those who have not been laid aside like myself.—E. M. JONES. July 1st, 1879.

The above was reprinted at the request of the patient, 20th November, 1883

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Hygiene.

BY ALFRED CARPENTER, M.D., M.R.C P. (LOND.),
Chairman of the Council of the Sanitary Institute.

FOOD—(*Continued*).

Alimentary substances differ in the number of elements which each contains; one is more solid than another, it may contain more carbon, or it may have a larger proportion of oxygen and hydrogen combined, existing in the form of water, or in chemical combination with the carbon. Popularly, liquid matters are considered to belong to drink rather than to food; but this is not a scientific division, for that which is a food may yet have nine-tenths of its weight water. Food and drink is not therefore a good classification. Attempts have been made to divide articles of diet into organic and inorganic foods; but water is inorganic, and it enters into the constituent parts of almost all organic compounds. A more definite arrangement has been made by dividing them into nitrogenised and non-nitrogenised foods, carbon, oxygen, and hydrogen in varying proportions forming the latter class, whilst the former have in addition to these, nitrogen, and some other of the elements which have been previously mentioned. This classification, which is Liebig's, was founded upon the idea that nitrogenised foods built up the body; and he styled them, '*plastic elements of nutrition*,' whilst he termed the non-nitrogenised foods, '*elements of respiration*'; but it has been shown by more recent physiological enquirers that nitrogenised compounds do assist to produce heat, and that tissue-forming materials leave hydrocarbons as *débris*, which may be used up in the production of heat. So fat is a non-nitrogenous substance; it belongs to what Dr. Pavy calls the *calorifacient* or *heat-producing* group of foods; but it is necessary to the production of some tissues, and ranks with the 'plastic elements of nutrition,' so that Liebig's classification fails. A chemical or physiological division into groups, which shall be correct, is not practicable; but the simplest classification may be taken as follows —viz. (1) *Inorganic.* (2) *Nitrogenous principles.* (3) *Fats or hydrocarbons.* (4) *Starches, sugars, carbohydrates.* (5) *Acids and alcohols* derived from changes which may take place in Class 4. These five classes include all the articles which can in any way be considered in the light of alimentary substances.

Inorganic Foods.—The inorganic alimentary principles consist for the most part of *water* and *mineral salts*, which latter may be in solution in the water or in chemical combination with organic matters. The presence of *water* is essential for the changes which are constantly taking place in the molecular condition of organic life. Without it no vital activity can arise, but mineral material is also absolutely necessary for the continuance of molecular activity. The processes called *endosmose* and *exosmose*, and which are always associated with cell-production, could not be continued if it were not for the changes which are produced in the densities of liquids on the principle of *osmosis*. This is a term which is applied to the passage of fluids through membrane, the membrane acting as a septum between fluids of different densities and different chemical constitutions. Thus, if ordinary bladder be placed between water and alcohol there is a current from the water to the alcohol, because the membrane as well as the alcohol has a great affinity for the water. It is probably partly by reason of this principle that absorption, assimilation, and secretion are perfected in living tissues, saline solutions of varying densities, with organic matter, assisting to determine the directions in which the fluids should travel, and bringing about those chemical conditions upon which the development of pseudo-galvanic or nerve excitation may take place, whilst it is intimately connected with the changes which arise in the blood-current in the lungs, for the blood corpuscles, by their affinity for oxygen, take in that gas and give up in exchange the CO_2 which they contain in excess. The corpuscles then carry the oxygen gas to distant parts of the organism and attract carbon into their structure in exchange for oxygen; heat is given out by the condensation which ensues, and thus temperature is kept up. Other chemical changes take place in the constituent elements of the blood: salines and other mineral particles, such as the phosphates, are appropriated by this or that organ, and the incessant activity which is styled 'vital energy' is maintained. One of the most important mineral elements in organic life is phosphate of lime. Its combination with nitrogenous matter is so intimate that the greatest difficulty is experienced in separating them. If the separation is

effected the compound is destroyed. It seems as if phosphorus, in combination with lime, was absolutely essential to the development of vital activity in all cell-growth among the higher organisms. The chief saline principles are combinations of lime, magnesia, potash, soda, and iron, with chlorine, phosphoric acid, carbonic acid, and, in a slight degree, sulphuric acid. It is usual in conducting an analysis to incinerate the body to be examined, and then to analyse the ash, but this is not advantageous, except it be carried out in combination with other processes, for the carbon is driven off as carbonic acid, and the saline principles, under the elevated temperature to which they are subjected, occupy combinations which are different to those which they hold in the living tissues. These mineral elements occupy different places in the living organism, for they cannot be made to replace one another. Soda will not fulfil the proper requirements when potash is wanted, and lime cannot take the place of magnesia. Phosphates and potash salts are more abundant in the blood-corpuscles, whilst it is the chloride of sodium which is most abundant in the serum. The processes may be seen at work in the changes which take place in the common egg. The phosphorus which is present in the yolk becomes oxidised and converted into phosphoric acid. This reacts upon the shell, dissolving the lime and conveying it into the circulation of the chick, thus assisting in forming the bony skeleton of the fowl. The value of food will depend, to some extent, upon the kind of mineral matter which enters into its constitution, and in the preparation of food for the purposes of life, this view of the matter is but too often forgotten. Meat soaked in water and boiled is less nutritious than roasted meat, for some of its salines have been abstracted; and roasted potatoes, for the same reason, are more nutritious than boiled. But it is the staff of life, viz., household bread, which is depreciated most by the fashion with which which it is dealt with as flour. Most of the salines and nearly all the nitrogenous matters of wheat are contained in the outer part of the seed, and are taken away by the millers. Liebig has asserted that an immense number of persons could be fed upon the same quantity of wheat, if it were possible to persuade the people of the advantages which would arise from the use of unbolted flour, that is, of flour from which the glutinous matter of the outer skin has not been removed. The agitation which has been set on foot by Miss Yates, for the promotion of information among the people upon this point, is worthy of notice; for, although I am not inclined to go as far as Liebig in his views upon this point, we can obtain the missing ingredients from other articles of food, which, if not consumed, would be otherwise wasted or not produced; yet, for the benefit of the lower classes generally, it is highly important that they should not regard white bread as a better article than the brown, for the brown contains the larger portion of the mineral and glutinous part of the corn. It is the presence of these ingredients in wheat which gives its greater value over rice as supplying 'plastic elements of nutrition.' Rice is the least nitrogenous of all the cereals, and has scarcely any phosphate in its composition; it goes well with highly plastic food, but it cannot be taken as the only food for any length of time, without evil resulting to the constitution from its use. This example shows the necessity for mineral matter in the daily food. At the same time bran is not to be used as an exclusive diet, for the particles of which it consists will irritate the bowels and set up diarrhœa, if partaken of too freely. This action indicates one of the uses of the outer skin of wheat in nature, viz., to assist in regulating the bowels, but, like everything else, it is injurious if taken in excess.

Nitrogenous Aliments.—Nitrogen forms four-fifths of the atmosphere, but as a gas it is simply noted for its negative properties; it seems incapable of doing anything. But when it has been brought into combination with other elementary bodies by the aid of vital activity, we get organic nitrogenous matters which are anything but negative in their powers. Carbon, hydrogen, oxygen, having entered into combination with nitrogen, by means of vital activity, the so-called *proteine* compounds are formed, such as *albumen*, *fibrine*, *caseine*, and their modifications, viz.: *vitelline*, *globuline*, *syntonine*, *gelatine*, *chondrine*, etc.

It is very important to determine the nutritive value of different articles of diet: attempts have been made to fix standards by which the value of different kinds may be calculated, so that that which is economical may be differentiated from that which is wasteful, and proper supplies of food afforded to large establishments, such as schools, hospitals, asylums, etc., or even to armies in the field.

A calculation has been made which has been based upon the supposition that a man requires 1220 grains of nitrogenous matter every day to keep him in health; but this is unsound, because some foods which are acknowledged by experience to be valuable, are found by analysis to be defective in these qualities, and it has also been discovered that work can be done without nitrogenous food at all. Other tables have been prepared, which are based upon the quantity of nitrogen in the dried substance; but in this calculation no account is taken of the indigestibility of the dried material and of the fact previously stated. Another method has been followed, in which the proportions of nitrogen and carbon have been estimated, and these have been compared with the proportions which are thought to be required by an able-bodied man as a standard diet, but before this can be satisfactorily arranged, we must consider the functions of food, that is, the reason why food is necessary. Its ultimate destination is for the manifestation of force, and in this operation it is reduced, more or less, to more simple forms, viz., carbonic acid, water, and ammonia. The forces which are produced are: (1) heat, and (2) motion. With the development of these powers, we have intimately associated those functions of the body which are involved in development and growth, excretion and decay. A consideration of these points, shows at once the difficulty which is involved in a hard-and-fast line of classification based upon either chemistry or physiology, and we have to fall back upon general principles.

Chemists recognise several well-defined compounds, to which reference has already been made, but which are not capable of being synthetically produced—that is, analysis shows them to consist of so many molecules of C. H. O. N. with minute proportions of P. or S., but which no power in the laboratory enables us to reproduce them without the aid of vital force. At the same time, chemistry helps us to make calculations as to the value of diets, because we find that some nitrogenous aliments are characterised by yielding *proteine*

when subjected to the action of alkali and heat, whilst in other cases that body cannot be procured. This chemical fact gives two divisions—(1) *The albuminous*, or proteine principles; (2) *The gelatinous*. The former can be obtained from the vegetable as well as the animal kingdom, but the latter are only found in the animal world, as gelatine from bones and chondrine from cartilage; these latter also do not contain phosphorus.

All the nitrogenous aliments must undergo digestion before they can enter the system; and to enable them to be absorbed, they must be liquefied and transformed. It is according to the ease and rapidity with which these processes are effected, and the forces which can be obtained from the changes which their elements undergo, that their value as diets depend. The changes are promoted by digestion, commencing with mastication. The process is completed when the aliment has become changed into *peptones*, or '*albuminose*,' as it has been styled by Lehmann and Mialle.

Albumen in the coagulated form is dissolved, and is not again coagulable. Fibrine is dissolved. Caseine is curdled, and then re-dissolved; and gelatine is liquefied. All together by the aid of the gastric juice they form chyme, and mixing with the pancreatic and intestinal juices, go through the several changes which are terminated by the reception of the valuable part of the metamorphosed food into the current of the circulation, and the rejection of the useless *débris* from the body.

The value of the material supplied is regulated by its power to assist in (1) development; (2) renovation, and in (3) the promotion of the functions of vitality which are evolved in the manifestation of the attributes of the special senses.

Nitrogenous matter, forming the instrument of living action, is continuously disintegrated, and the resulting *débris* is being continuously removed. The smaller the *débris* the greater the value of the food, and the less the chance of the living machine being clogged by useless matter.

It used to be assumed that nitrogenous matter was the only source of muscular power, but it has been clearly shown that it is not produced by muscular destruction, as Liebig supposed, and that nitrogenous matter is not supplied through muscle, but, at the same time, it has been also proved that a plentiful supply of it does increase the power of an individual to perform muscular work. This is effected by the direct utilisation of the carbon and hydrogen which it contains. The elimination of urea, as the *débris* of nitrogenous matter is called, and which is excreted by the urine, is related to the quality of the food supplied, and not to the muscular work performed; and more recent observations tend to show that the metamorphosis takes place in the liver, and not in muscle.

(*To be continued.*)

—o—

Friedrich Fröbel.

BY HIS PUPIL, HEINRICH HOFFMAN.

IX.

No wonder that so few were equal to such a task. Middendorf, however, had a wonderful way of maintaining his independence, and yet really submitting. And well he might; were there not so many points in which they were altogether one? That simple-minded earnest piety, that firm clinging to the eternal Bible truths, that unbounded love of mankind, that tender affection for little children, and last, not least, that sublime disinterestedness—were all equally marked in each of them. Middendorf was a child among children; Fröbel was spell-bound in the presence of a child. The sight of one, even at a distance, would act on him like a loadstone and would draw him a good distance out of his way, that he might have a friendly chat.

Their stay at Griesheim, however, was but short. There was nothing specially advantageous in that locality, beyond the fact that, of their six pupils (for Middendorf had brought with him Langethal's brother), three could live at home with their mother. But on the expiration of the customary privilege, allowed to widows of clergymen, Frau Fröbel purchased a small farm at Keilhau, a short distance west of Rudolstadt. A locality better adapted for educational purposes, it would certainly not be easy to discover. It is just as if nature had on purpose done her wisest and her best to produce a combination of the highest educational advantages. Fröbel's keen eye saw at once the realisation of his long-cherished dream, an ideal picture, that had often delighted his imagination. In June, 1817, they removed to the farmhouse. Frau Fröbel followed them some months later, when her own house had been thoroughly repaired.

The two friends had fully expected work, very hard work; but little did they know what difficulties they were to encounter.

We, in our days, are so accustomed to the luxury of school architecture and school appliances, that the tale of such privations, such extreme discomfort as they had to endure, seems to us utterly incredible. What with premises all but uninhabitable—if a mere carcase, minus doors, windows, and flooring, can in courtesy be called premises—a season of unprecedented misery, a disastrous famine raging over all Germany, and the utter absence of pecuniary resources—more than once they had to thank Mrs. Fröbel even for their bread—it is, indeed, a wonder how they held out.

But, fortunately, the woods abounded in wild strawberries and other delicacies of nature, and the boys were not over-fastidious. Did they not live in a country where fruit formed the principal ingredient of the meals of all the villagers, with the purest crystalline beverage fresh from the public well? a herring or a fried sausage being a private luxury enjoyed only by *paterfamilias*, when on market-days business called him to Rudolstadt.

New premises had to be built. In their poverty they endeavoured, as best they could with their own hands, to make their miserable abode habitable. They managed to obtain a schoolroom, rent free, compared with which all our grand palatial buildings are but pigeon-holes. It extended over an area more than two German miles in circumference, and it included mountains and hills and woods and rivulets, and the most delightful scenery; together with a library that was positively inexhaustible in its rich and wonderful treasures. And just as in an ordinary schoolroom, the broom and the cleaning brush are essential means of civilisation, so Middendorf took good care to leave behind him traces of culture, wherever he

came with his boys. Wherever there was a fine view there they erected seats. They eased the ascent of steep hills, laid out walks, planted trees. When they found a brooklet they searched for its spring, and bridged the stream at convenient points. On their return home with their rich harvest of flowers and curiosities of the mineral world, Fröbel was in his very element in classifying and naming the specimens thus collected.

At the fall of the year Langethal joined his friends, 'to share with them,' as Middendorf has it, 'the tormentingly delightful fate of a sublime sphere of labour amidst extreme exertions and almost incredible privations.' He was, indeed, an invaluable addition. A high reputation both as regards ability and character preceded him, for he had passed his theological examination with brilliant success. He was determined to devote himself heart and soul to Fröbel's work, and soon became a great favourite with the boys, who admired his manliness, his prowess in gymnastic exercise, his inexhaustible store of knowledge of history, and especially of the romantic lore of the Middle Ages.

Winter set in, and closed their delightful out-door schoolroom. They had to pull down and to rebuild with their own hands the stoves, to avoid being suffocated by the smoke. The pupils increased in number, and so did their cares and difficulties, but equally so their courage and their invincible ardour. The thought of earning money had never entered their minds. That they should share alike in the work, in the expenses, and in the earnings, was too much a matter of course to require much of an agreement Their faith in the idea that guided them was too great to be shaken by outward obstacles. It was enough for them that the young tree had struck powerful roots.

It was a matter of deep regret to them all when Frau Fröbel was obliged to leave Keilhau. She moved to Volkstädt, and Fröbel became, by purchase, owner of the farm.

All felt that a mother's superintendence of the increased household was now indispensable, but it required all the buoyancy of his spirit, all the courage and the unremitting faith of Fröbel to induce him to think of marrying. And yet, ever since his inspectorate at Berlin, he cherished in his innermost heart the memory of a lady, who had made a deep and lasting impression on him. It was Wilhelmine, daughter of Herr Kriegsrath, Councillor of War, Hoffmeister, a lady of high intellectual attainments, of the purest and noblest aspirations, large-hearted, and enthusiastically devoted to philanthropic labours.

In the company of her father, she had been a frequent visitor at the museum. Fröbel, in his animated manner, had there revealed to her a rich vein of intellectual treasures. The earnestness of his mind, his high aspirations, the grandeur of his character, could not fail to excite her admiration. He had never forgotten those interesting conversations, and frankly divulging to her his position and the state of his affairs, he ventured to ask her to his humble home. She readily consented to give up a life of comfort and luxury with the refined enjoyments of a high social circle, and joined him on his thorny path on the 20th of September, 1818, the anniversary also of her birth.

(To be continued.)

The New Class-Subject, 'Elementary Science.'

(What to teach, and how to teach it.)

BY RICHARD BALCHIN.

CONTINUING the scheme of lessons for Standard III., as given in the February issue of the PRACTICAL TEACHER, we now come to the subject-matter of Chapter VI., *i.e*, 'Useful Vegetables.'

LESSON 21.—CORN.

Objects exhibited: Specimens of common grasses, and of wheat, oats, barley, rye, and rice. Picture of flour-mill, etc.

(*Note.*—By pasting together sheets of cartridge-paper, I have made a number of paste-boards four feet long and eighteen inches wide. These are stiff enough to stand up on end before the class. On these cards I have mounted the specimens above alluded to, and they make really attractive objects. It is easy to obtain good specimens three to four feet high of such grasses as—'Triticum repens,' to compare with wheat; 'Holcus lanatus' fully out, to compare with oats; 'Poa trivialis' and 'Poa pratensis,' 'Lolium perenne,' etc. The specimens of corn are similarly mounted. In my old British school, over twenty boys had themselves made collections of grasses, named and mounted. But this was before the advent of the Code.)

First note that all kinds of corn are but cultivated grasses. Distinguish, by means of the specimens, between wheat and barley, and between oats and rice. Describe, conversationally, the operations—(1) Sowing, (2) Reaping, (3) Threshing, and (4) Grinding. Notice the general composition of this kind of food, *i.e.*, make a little wheaten dough; knead it in the hands while a boy pours over it a little cold water; the water runs off 'milky' in appearance, due to the presence of starch. What remains is mostly gluten, rather sticky. Pour a little of the milky water into a test-tube, and add a drop or two, not more, of iodine solution; the starch-water turns blue.

LESSON 22.—POTATOES AND GREENS.

Objects exhibited: A potato, a good 'hearted' cabbage cut in halves; picture of same; a bread grater, and iodine solution; also, if possible, a horse-radish and carrot.

For a good dinner, we generally have with the meat potatoes and greens. Potato, from the root of the potato-plant; not itself a root. Compare potato with carrot; the 'eyes' of the former are 'buds,' *i.e.*, leaf-buds. No buds on the carrot, only fibres. Hence, potato not a root, really a kind of underground stem, called a 'tuber.' Horse-radish, like the carrot, *is* a root. Show section of cabbage; really a great leaf-bud. Central stem (axis) trying to force its way up. If the cabbage 'runs to seed' it *does* so force its way up and bears flowers and seeds.

Wash out the starch from the potato, as described on page 116 of the 'Science Reader' for Standard IV.

Note.—The subject-matter of Lessons 23 to 27 is fully given in the 'Reader' for Standard III.

LESSON 28.—THE PLANE AND SYCAMORE.

Objects exhibited: Pictures of these trees; specimens of their leaves and of their fruits.

Carry on a conversation about the pictures, noting, 1st, the points of likeness between these trees, *i.e.*, both have smooth woody trunks and spreading branches; both large ornamental trees; leaves very nearly the same pattern in both; wood light-coloured and durable, easily worked. 2nd, Points of dissimilarity. The fruit of the plane quite unlike that of the sycamore. On the plane the flowers and fruits are in ball-clusters on pendulous stalks; two or three balls on each flower-stalk: to each flower in the cluster there is a seed-case, containing one or two seeds. The green flowers of the sycamore are thickly clustered around a pendulous stalk; not many of the flowers really producing seeds; sometimes only four or six in each cluster. The fruit is a pair of winged seed-cases, joined at their swollen ends. If such a pair be thrown up into the air, it spins round and round, hence the childish name—'dicky birds.' Plane trees are often planted in school playgrounds, or by the side of the road in large towns. They are on the Thames Embankment. This tree is a native of North America. It comes in leaf after the sycamore. The bark often peels off in cakes, leaving white patches on the trunk. The sycamore is really a maple, and should be called the sycamore-maple.

LESSON 29.—THE OAK.

Objects exhibited: Pictures of the oak—(1) A tree grown naturally; (2) A pollard oak, *i.e.*, one whose central stem has been cut for the purpose of inducing it to throw out branches around the section. Some oak-leaves and wood, acorns, oak-galls, and a sharp penknife. Also, if possible, an infusion of oak-galls, made by breaking up three or four of them and soaking in hot water; a little of the solution of sulphate of iron (copperas).

Compare the oak with the plane or sycamore (1) As to trunk: oak, rough, often gnarled; plane, smooth; trunk of pollard oak very large, often hollow. (2) As to shape of leaves. Oak not planted by road-side. Why? Very slow growth. Two kinds of flowers on the oak; only one kind comes to acorns. Compare vegetable marrow and cucumber. (Better not use the technical terms for these unisexual blossoms. Call the staminate flowers 'pollen flowers,' and the pistillate ones 'fruit flowers.') Seems to be two kinds of fruit on the oak-tree, *i.e.*, acorns and oak-galls. Oak-galls not a fruit. It is a case made by an insect, in which to lay an egg. Egg comes to a grub or maggot, which eats its way through the case and becomes a small fly. Cut open a few galls to illustrate this. Note that the steel knife is blackened. Put some clear infusion of galls in one test-tube, and some clear solution of copperas in another, pour the two together into a third tube, and so make black ink.

The subject-matter of Lessons 30 to 36 is given with sufficient fulness in the 'Reader.'

LESSON 37.—WATER FREEZING AND BOILING.

Objects exhibited: A thermometer; some ice and salt; can of water; a basin; a narrow test-tube. An empty oil-flask, and retort-stand. A spirit-lamp and a piece of pointed glass tube (*i.e.*, a pipette).

Carry on conversation about the thermometer. Note the freezing-point of water, 32°; this is not the freezing-point of all liquids—the mercury in the thermometer, for instance. Boiling-point of water, 212°; not shown on ordinary thermometer; not long enough. Heat of healthy body, 98°. Mix some broken ice and water; place the glass in the water; mercury sinks to 32°. Mix some broken ice and salt; mercury sinks below 32°. Place in this mixture the little test-tube, with a small quantity of water in it. The water is frozen—*i.e.*, ice and salt, a freezing mixture. Boil some water in an empty oil-flask over a spirit-lamp; describe the behaviour of water when boiling. To show how upward currents are produced, introduce a finely-pointed glass-tube, containing a little thick black ink, so as to allow a small stream of ink to run out into the water in the lower part of the flask. The ink will be carried upward, and for a time remain quite distinct from the water.

The subject-matter of Lessons 37 to 42 is fully given on pages 74 to 94 of the 'Reader' for Standard III. and on page 73 of the 'Reader' for Standard IV.

LESSON 43.—NATURE'S WORK.

Objects exhibited: Picture of a country scene during a storm, or during a shower; the one illustrating a rainbow will answer the purpose.

Allow the boys to talk freely about the picture; leading them to note (1) the downpour of rain and then its effects—*i.e.*, (*a*) washing the streets or roads; carrying away material to the gutters, then to the sewers, to the rivers, to the sea. The same with the general surface of land, *i.e.*, removing the land to ponds, or lakes, or river-deltas, or to the sea. (*b*) Clearing the air of impurities, such impurities being brought down to the earth to become food for plants. All such work is done independently of man. It is Nature's work. (2) Note that the rain comes from the clouds. Clouds are masses of water-vapour, which have been raised from the surface of the earth to the air by the sun. Sunshine, drying up the streets, etc., after a shower. Many tons of water fall as rain; therefore many tons of water lifted into the air by the sun. A great work. Not man's work; it is one of the great works of Nature. (3) Note the trees, grass, flowers, and corn all living, feeding, and growing. Mostly the work of the sun. The sun's heat brings out the buds and leaves of spring, forms the summer blossoms, and ripens the autumn fruits. Not altogether the work of man, who only assists in the great work of the sunshine and the shower.

LESSON 44.—'THE WORK OF THE SUN.'

First: Ripening Fruits and Seeds.

Objects exhibited: Picture of cornfield or orchard. An apple or orange. A grain of corn sprouting.

Show the sprouting grain. Describe the spring wheat appearing and growing, as the work of the spring sun. Then the hot sun of August ripens the grain. Note the difference between the fruit and the seed. Cut the apple open and show the seeds. Call the fruit the 'seed-case.' Give other illustrations of this, *i.e.*, show the seeds in the grape or the gooseberry. With such fruits as the apple, orange, plum, grape, etc., the 'ripening' is really the formation of sugar in the substance of the plant or fruit. Instance the terms 'grape-sugar,' 'cane-sugar,' etc. This 'sugar-making' is the work of the sun. Note that starch is formed before sugar.

(To be continued.)

Physiology.

BY ARTHUR NEWSHOLME, M.D. LOND.,

Gold Medallist and University Scholar, Physician to the City Dispensary.

CHAPTER VIII.—*(continued).*

The liver is situated under cover of the ribs on the right side of the body, fitting into the concave surface of the diaphragm. It is the largest gland in the body, measuring from ten to twelve inches transversely, and weighing in the adult an average of from fifty to sixty ounces. It is solid to the feel, and of a dull reddish-brown colour. It is imperfectly divided into a right and left lobe, and the right lobe shows three secondary lobes or lobules. The surface is covered, like that of most of the abdominal organs, by the peritoneum, and certain folds of the peritoneum form ligaments fixing the liver in position. Inside the peritoneum is a coating of areolar or fibrous tissue, which at the portal fissure (that is, the place where the portal vessels enter the liver) becomes continuous with a fibrous sheath, known as the *capsule of Glisson*, enveloping the portal vein, hepatic artery, and hepatic duct as they branch in the substance of the liver.

It will be convenient before describing the intimate structure of the liver to enumerate its vessels and ducts, and show how they are connected with the alimentary canal. On the under surface of the liver can be seen two small ducts which bring the bile from the substance of the liver. They join together to form the *hepatic duct* (Greek, *hepar*, the liver), as seen at *b*, Figure 39. The hepatic duct is joined at an acute angle by the *cystic duct*, which is one and a

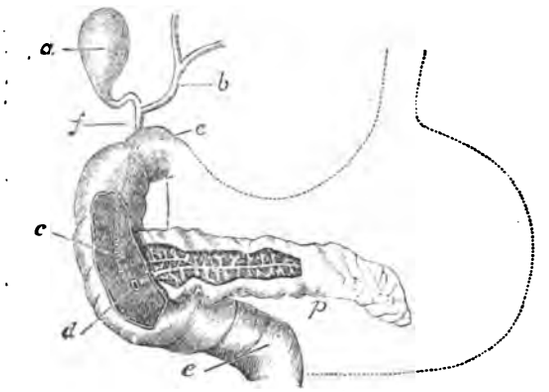

Fig. 39.—Showing relation of ducts opening into duodenum. (*a*) Gall-bladder. (*b*) Hepatic duct. (*c*) Opening of a pancreatic duct. (*d*) Opening of a tube formed by junction of common bile duct and a pancreatic duct. (*e*) Duodenum cut open to show orifices of ducts. (*f*) Common bile duct. (*p*) Pancreas, also cut across in part of its course to show the commencement of ducts.

half inches long, and brings the bile from the gall-bladder. The *gall-bladder* lies on the under surface of the liver, being fixed to it by areolar tissue. It forms a reservoir in which bile is collected until required in the intestine; and it is probable that the stimulus furnished by the passage of food over the orifice where the common bile duct opens into the intestine, is sufficient to cause a contraction of the involuntary muscular fibres in the wall of the gall-bladder, and consequently an expulsion of its contents.

The *common bile duct* formed by the junction of the hepatic and cystic ducts, is nearly three inches in length, and passes down to pierce the duodenum near its middle, running obliquely for three-quarters of an inch between its coats, and finally entering the intestinal canal.

The liver is supplied with blood from two sources—the portal vein, and the hepatic artery. The portal vein brings the blood from most of the alimentary canal, and from the spleen; it enters the substance of the liver along with the hepatic artery and the hepatic duct; and the three together run in small canals, called *portal canals*, which are each invested by a portion of Glisson's capsule.

The substance of the liver is made up of a multitude of minute *lobules*, varying from a half to one line in diameter. These are polyhedral masses not completely isolated from one another; each one consisting of a mass of cells penetrated by a close network of blood capillaries, and by the capillary commencements of the bile ducts. The cells composing the main mass of the lobules are from $\frac{1}{1000}$ to $\frac{1}{800}$ inch in diameter, polyhedral in shape, each containing a clear round nucleus, and one or two nucleoli. The cell substance is granular and of a faint yellowish tinge; occasionally fat globules are also visible. The cells are packed round the vessels, and when seen in a cross-section appear as if radiating from the centre of the lobule towards its circumference.

The exact nature of the origin of the bile ducts is somewhat doubtful. It has been already stated that the larger bile-ducts accompany the branches of the portal vein, and ramify with them in the outer part of each lobule. There can be little doubt, however, that they penetrate the substance of the lobule, and that here biliary capillaries are formed, which between the lobules form minute biliary ducts, and join with others, finally leaving the liver as the hepatic ducts. It is still doubtful whether these biliary capillaries have distinct walls of their own, or are mere channels between the individual cells of the lobule.

The portal vein in its course through the liver breaks up into capillary vessels, an event which is only paralleled in the case of the veins leaving the Malpighian tufts of the kidney. It first gives off small branches, accompanying those of the hepatic duct, which divide again and again between the lobules, and are hence called the *inter*-lobular veins. From these small veins a dense capillary network penetrates the substance of the lobule, which gradually collects itself into a larger vessel at the centre of the lobule, called the

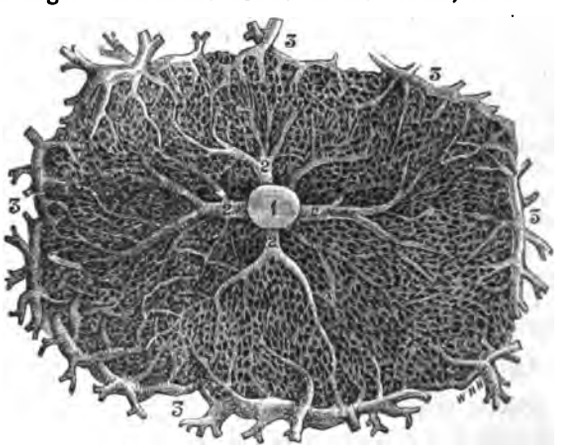

Fig. 40.—Cross-section of a lobule of the human liver, magnified six times.

1. Intra-lobular vein cut across. 2. Its smaller branches gathering blood from the capillary network. 3. Inter-lobular veins, with ramifications passing inwards to form the capillary network.

intra-lobular vein. This arrangement is well shown in Figure 40. The small intra-lobular veins discharge their contents into veins called *sub*-lobular. These join together and form the branches which finally leave the liver by two or three trunks known as *hepatic veins*, and then empty their contents into the inferior vena cava.

Thus we have—

1. PORTAL VEIN.
2. Inter-lobular Veins.
3. Capillaries.
4. Intra-lobular Veins.
5. Sub-lobular Veins.
6. Hepatic Veins.
7. INFERIOR VENA CAVA.

The hepatic artery is distributed in a similar manner to the portal vein, its function being to supply nutriment to the tissues of the liver.

The Pancreas lies within the curve formed by the duodenum, and behind the stomach. It is usually from six to eight inches long, and its weight is variable, but usually about two and a half to three ounces. In its general characters and minute structure, the pancreas closely resembles the salivary glands, belonging to the class of compound racemose glands. The duct by which its secretion is poured into the alimentary canal is well shown in Figure 39. It runs through the walls of the intestine side by side with the common bile duct, and terminates by a common opening in the mucous membrane. Occasionally part of the sacculi open by a duct at a separate point of the duodenum.

(To be continued.)

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Recent Inspection Questions.

[*The Editor respectfully solicits contributions—all of which will be regarded as* STRICTLY PRIVATE—*to this column. For obvious reasons, it cannot be stated in which district the questions have been set.*]

Arithmetic.

STANDARD I.—DICTATED.

(1)	(2)	(3)	(4)
609	47	605	915
8	824	386	618
76	90		
90	706	219	297
849	7		
1632	1674		

STANDARD II.—DICTATED.

(1)	(2)	(3)
8491	20579	11)55396
495	708	5036
7996	14569932	

STANDARD III.

(1) A lady went a-shopping with £10 in her pocket. She spent 19s. 6d. in groceries, 7s. 9d. in boots, and £5 0s. 11d. in dresses; how much money had she left? Ans. £3 11s. 10d.

(2) Divide ninety-three thousand one hundred and two by ninety-five. Ans. 980—2.

(3) £567 18s. 6½d. + £4920 6s. 10d. + £51783 19s. 11¾d. + £2202 16s. 0¼d. + £2867 15s. 7½d. (Given partly in words). Ans. £62,342 17s. 0d.

(4) £9001 14s. 9½d. − £183 15s. 10¾d. (words). Ans. £8817 18s. 10½d.

STANDARD IV.

(1) Take 5000 farthings from 5000 shillings. Ans. £244 15s. 10d.

(2) Out of 16 cwt. of butter, a grocer sells 27 lb. daily for 5 days. How much has he still on hand? Ans. 14 cwt. 3 qrs. 5 lbs.

(3) Divide £8 8s. 0½d. equally among 109 men; how much will each get? Ans. 1s. 6½d.

(4) Bring 17 sq. yds. 8 sq. ft. 120 sq. ins. to sq. ins. Ans. 23,304 sq. ins.

STANDARD V.

(1) Add together $\frac{1}{5}+\frac{2}{3}+\frac{3}{6}+\frac{4}{9}$, and from the sum take $\frac{1}{12}$. Ans. $1\frac{41}{180}$.

(2) 9461 articles at £11 14s. 3½d. each. Ans. £110,831 13s. 5½d.

(3) If a man's salary for a year be £136 17s. 6d., how much would he require for 25 days' service? Ans. £9 7s. 6d.

(4) If 25 horses cost £1076 10s., what would 75 cost? Ans. £3229 10s.

STANDARD VI.

(1) $(13\frac{1}{2}$ of $\frac{5}{9}) + (1\frac{2}{11}$ of $\frac{22}{25}) - 7\frac{24}{25}$. Ans. $\frac{1}{2}$.

(2) Bring $\frac{9}{14}$ of £1 2s. 11½d. to the fraction of $\frac{3}{11}$ of £3 12s. 1½d. Ans. $\frac{3}{4}$.

(3) Multiply ·0132 by ·021, then divide the result by ·00084. Ans. ·33.

(4) Find the simple interest of £10 3s. 4d. for $3\frac{1}{2}$ years at $2\frac{1}{2}$ per cent. Ans. 17s. 9½d.

STANDARD VII.

(1) In a dictation exercise given to a class of 36 boys, $\frac{1}{6}$ had no mistakes, $\frac{1}{4}$ had one each, $\frac{4}{9}$ had two each, $\frac{1}{12}$ had three each, and the remainder had four each. Find the *average* number of errors. Ans. $1\frac{11}{18}$ each.

(2) In a school of 400 children 31 per cent. are boys, 41 per cent. are girls, and the rest infants. Find the number of each. Ans. 124 B., 164 G., 112 I.

(3) A dealer buys toys at 10s. a gross, and sells them at a penny each; find his gain per cent. Ans. 20 per cent.

(4) The discount on a bill due 10 months hence at 6 per cent. is £70. Find the amount of the bill. Ans. £1470.

Domestic Economy.

STAGE I.

(1) What is flax? What materials are made from it?

(2) What advantages have knitted stockings over woven ones?

(3) What should be done with the lines and pegs after the clothes are taken in from the drying yard?

(4) What kind of clothes should be worn in summer, and what kind in winter? Why?

(5) What foods contain respectively albumen, fibrine, gluten, and casein?

(6) What foods contain fatty substances?

ANSWERS TO
Pupil Teachers' Examination Papers.

FEBRUARY 23.

FIRST YEAR.

Pupil Teachers at end of First Year.

Three hours and a half allowed.

Arithmetic.

MALES.

1. Define a fraction. Explain why a fraction is decreased by increasing the denominator, and why $\frac{3}{7}$ is $= \frac{6}{21}$.

A fraction denotes a part or parts of a unit; it is expressed by two numbers placed one above the other, with a line drawn between them; the lower being called the denominator, and the upper the numerator: thus $\frac{3}{7}$ denotes that the unit is divided into seven equal parts, and two of these parts are taken to form the fraction. Every fraction represents a quotient, the upper number being the dividend, the lower, the divisor. If the denominator be increased, the fraction itself is decreased, for whatever be the meaning of $\frac{6}{8}$, the fraction $\frac{6}{8\times2}$ or $\frac{6}{16}$ means only half as much, because here the dividend remains the same and the divisor is doubled, wherefore the quotient is diminished one-half.

If the numerator and denominator be both multiplied or both divided by the same number, the value of the fraction remains unaltered.

In the fraction $\frac{2}{7}$, the unit is divided into seven equal parts, and two of these parts are taken; in the fraction $\frac{6}{21}$ the unit is divided into twenty-one equal parts, and six of such parts are taken. Now there are three times as many parts taken in the second fraction as there are in the first fraction; but three parts in the second fraction are only equal to one part in the first fraction; therefore the six parts in the second fraction equal the two parts taken in the first fraction; therefore $\frac{2}{7} = \frac{6}{21}$.

2. Multiply the difference between $3\frac{1}{2}$ of $1\frac{1}{14} + 7\frac{1}{2}$ and $2\frac{1}{7} \div \frac{3}{5}$ of $\frac{6}{21}$ by the sum of $\frac{1}{4\frac{2}{3}}$ and $\frac{1}{5\frac{2}{7}}$.

(*a*) $3\frac{1}{2}$ of $1\frac{1}{14} + 7\frac{1}{2} = \frac{7\times15}{2\times14} + 7\frac{1}{2} = 8\frac{1}{4}$

(*b*) $2\frac{1}{7} \div \frac{3}{5}$ of $\frac{6}{21} = \frac{15\times3\times21}{7\times2\times5} = \frac{27}{2} = 5\frac{4}{2}$

difference between (*a*) and (*b*) $= \frac{3}{4}$

(*c*) $\frac{1}{4\frac{2}{3}} + \frac{1}{5\frac{2}{7}} = \frac{1}{\frac{14}{3}} + \frac{1}{\frac{37}{7}} = \frac{3}{14} + \frac{7}{37} = \frac{209}{518}$.

Difference between (*a*) and (*b*) multiplied by result of (*c*)
$= \frac{3}{4} \times \frac{209}{518} = \frac{627}{2072}$. Ans.

3. Find in money the value of 2·8675 of £5 1cs.; and express 3 po. 5½ yds. as the decimal of an acre.

(*a*)

£
2·8675
5·5
1 43375
14 3375
£15·77125
20
15·425s.
12
5·1d.

(*b*)

$$\frac{3 \text{ po. } 5\frac{1}{2} \text{ yds.}}{1 \text{ ac.}} = \frac{3\cdot18 \text{ po.}}{1 \text{ ac.}} = \frac{\cdot07954 \text{ ro.}}{1 \text{ ac.}} = \cdot0198863\tfrac{1}{2} \text{ ac.}$$ Ans.

∴ Ans. = £15 15s. 5·1d.

4. A can do a piece of work in 8 days and B in 10 days; after A has worked 3 days B joins him. In how many days will the work be finished from the time A began?

A does $\frac{1}{8}$ of the work in 1 day and $\frac{3}{8}$ in 3 days;
B ,, $\frac{1}{10}$,, ,,
∴ A and B do $\frac{1}{8} + \frac{1}{10}$ or $\frac{9}{40}$ in 1 day.

Now after A does $\frac{3}{8}$ there are $\frac{5}{8}$ to be done.
∴ $\frac{9}{40} : \frac{5}{8} ::$ 1 day : Time they take to finish.

$$\frac{1 \text{ day} \times 5 \times 40}{8 \times 9} = \frac{25}{9} = 2\tfrac{7}{9} \text{ days.}$$

∴ From the time A began, the work has consumed
3 + $2\frac{7}{9}$ days or $5\frac{7}{9}$ days. Ans.

FEMALES.

1. Find the value of 15 yds. 2 ft. 3 in. at £2 7s. 10d. per yd.

£	s.	d.	
2	7	10	= cost of 1 yd.
		5	
11	19	2	= ,, 5 yds.
		3	
35	17	6	= ,, 15 yds.
1	3	11	= ,, 1 ft. 6 in.
0	11	11½	= ,, 9 in.
37	13	4½	= ,, 15 yds. 2 ft. 3 in. Ans.

18 in. = ½ of 1 yd.
9 in. = ½ of 18 in.

2. What is the largest number that will divide both 475 and 589; and the smallest which will contain 18, 28, 30, and 42?

(*a*)

4	475	589	1
	456	475	
	19	114	6
		114	

G.C.M. = 10. Ans.

(*b*)

2)18, 28, 30, 42,
3) 9, 14, 15, 21,
7) 3, 14, 5, 7,
3, 2, 5, 1.

∴ L.C.M. = 2×3×7×3×2×5 = 1260. Ans.

3. Add $\frac{2}{3}$, $\frac{3}{8}$, and $1\frac{7}{12}$; and subtract from the sum $\frac{11}{20}$.

(*a*) $(\frac{2}{3} + \frac{3}{8} + 1\frac{7}{12}) = \frac{48 + 45 + 70}{120} = 1\frac{43}{120}$ = sum. Ans.

(*b*) $1\frac{43}{120} - \frac{11}{20} = \frac{163 - 99}{120} = 1\frac{64}{120} = \frac{8}{15}$ = diff. Ans.

4. I spend ⅓ of my money; then ¼ of what remains; and lose ⅕ of what is still left. What fraction of the whole will be left?

After spending ⅓ there remains ⅔ of whole;
,, ¼ of ⅔ there remains ⅔ of ⅓ or ⅙ of whole;
,, ⅕ of ½ there remains ⅘ of ½ or $\frac{2}{5}$ of whole. Ans.

Grammar.

MALES AND FEMALES.

1. *Here* Ouse, *slow winding* through a level *plain*
Of spacious *meads* with cattle *sprinkled o'er*,
Conducts the eye *along* his sinuous course
Delighted. COWPER.

Analyse the above, parsing the words in italics.

ANALYSIS.

I. *Subject* ... ... 'Ouse.'

II. *Attributive adjuncts of subject* ... 'slow winding through a level plain of spacious meads with cattle sprinkled o'er.'
'slow' *adv. of manner, mod.* the verb 'winding'; 'through a level plain' *adv. phrase, mod.* 'winding'; 'of spacious meads,' *adj., phr., attrib. to* 'plain'; 'with cattle sprinkled o'er'; *part. phr., attrib. to* 'plain.'

III. *Predicate* ... ... 'Conducts.'

IV. *Object* ... ... 'eye.'

V. *Attributive adjuncts of object* ... ... 'the,' *adj.* or *article*; 'delighted,' *part.*

VI. *Adverbial adjuncts* ... 'here,' *adv. of place.*
'along his sinuous course,' *adv., phr. of place.*

PARSING.

Here—adv. of place, mod. 'conducts.'
slow—adv. of manner, mod. 'winding.'
winding—incomplete part. of the irreg. intrans. verb *wind, wound, wound*, predic. of 'Ouse.'
plain—com. noun, neut., sing. obj., gov. by prep. 'through.'
meads—com. noun, neut., plu. obj., gov. by prep. 'of.'
sprinkled—complete part. of the reg. trans. verb *sprinkle*, predic. of 'meads.'

o'er—adv. of manner, mod. 'sprinkled.'
conducts—reg. trans. verb, indic. pres., indef., 3rd pers., sing., agr. with 'Ouse.'
along—prep., showing relation between 'conducts' and 'course.'
delighted—complete part. of reg. trans. verb *delight*, predic. of 'eye.'

2. Mention verbs ending in 'le,' like 'sprinkle.'

English verbs ending in 'le' have a frequentative meaning; as, dazzle, twinkle, prattle, puzzle, rattle, rustle, dimple.

3. Give examples of adjectives ending in 'ish' and 'en,' and explain the significance of those terminations.

Adjectives ending in 'ish' have a diminutive meaning, or a partaking of the quality of the word from which the adjective is formed; as, boyish, whitish, blackish, childish.
Adjectives ending in 'en' mean 'made of'; as, golden, wooden, brazen, waxen, woollen, wheaten.

Geography.

(*Answer either Question* 1 *or Question* 2, *not both.*)

1. Draw a map of the north-eastern counties of England (Northumberland, Durham, and Yorkshire); and describe, as fully as you can, *referring at each step to your map*, the river-basins of these counties, and the boundaries of those basins.

N.B.—Insert the lines of latitude and longitude.

In the north of England there are three river-basins which are but slightly separated, and whose slopes almost coincide in direction—the *basins of the Tees, Wear, and Tyne.* These rivers rise near each other in the neighbourhood of Cross Fell, and flow in an easterly direction. The name Wear Dale Forest is given to the watershed which separates the basins of the Tyne and the Wear, and Teesdale Forest to that which separates the basins of the Wear and the Tees. The Tees basin is separated from the basin of the Yorkshire Ouse by spurs from the Pennine and York Moors. The Tyne drains the country which occupies the angle between the Pennine Moors and the Cheviots.

2. Say what you know about Anglesea, Argyllshire, and Galway.

Draw an outline map of *one* of these counties, and insert the lines of latitude and longitude.
Anglesea is an insular county in the N.W. of Wales. Its surface is comparatively flat, and its climate is mild, but unfavourable to the growth of timber. The soil is fertile and well cultivated, but its manufactures are insignificant. The minerals are copper, lead, and silver ores, coal, marble, and granite. There are many Druidical remains. The chief towns are Beaumaris, Amlwch, and Holyhead connected with Dublin by a submarine telegraph.
Argyllshire lies in the extreme west of Scotland, and chiefly consists of peninsulas and islands. It is the second largest county in Scotland, and one of the most thinly inhabited. The surface is mountainous, and only a small part is cultivated. Cattle are reared for exportation. The chief towns are Inverary, Dunoon, Campbelltown, Oban, Bowmore (in Islay), and Tobermory (in Mull).
Galway is a maritime county in the west of Ireland. It is the second largest of Irish counties, and its coast is extremely rugged and deeply indented. The surface is extremely mountainous in the west, Connemara being one of the wildest districts in Ireland. The east is flat and fertile, but interspersed with bog. The climate is humid and mild. Oats and potatoes are the chief crops. Cattle are extensively reared, and the coast fisheries are valuable. The Irish language is general in many districts of the county. The chief towns are Galway, Tuam, Ballinasloe, and Loughrea.

3. Trace minutely the journey of a traveller, landing in Nova Scotia, and going by land to British Columbia. Describe, in the order in which he would come to them, the physical features of the country, and the chief towns on his route.

Landing at Halifax, whose fine harbour is the admiration of the world, the traveller may proceed across Nova Scotia through a generally undulating but not mountainous country into New Brunswick, whose surface is varied, its northern part forming a table-land, having upon it numerous ranges of hills and studded with lakes. Its centre part rises gradually from the St. Lawrence towards the interior for a considerable distance. Generally, the natural features of this province are picturesque rather than bold and startling. The capital is Fredericton, a pretty town; but the chief place is St. John, one of the most picturesque and flourishing cities of the North American Provinces. Leaving New Brunswick, the traveller enters the Province of Quebec (formerly Lower or East Canada), which is characterised by picturesque scenery, consisting of boundless forests, magnificent rivers and lakes, extensive prairies, and bold, rocky heights. Quebec, the capital, is very strongly fortified, stands on the north bank of the River St. Lawrence; and Montreal, on an island at the confluence of the St. Lawrence and Ottawa, has a thriving trade. The tubular bridge, which carries the Grand Trunk Railway over the St. Lawrence, is one and a quarter miles long. He is now in the Province of Ontario, the surface of which is gently undulating, and diversified with lakes and rivers, the lakes being numerous and magnificent. Proceeding along the route of the Canada Pacific Railway, he traverses the marshy district on the north of the great lakes, and reaches the great prairie land of Manitoba, with its busy capital Winnipeg. Continuing his now wild and inhospitable journey through the prairie region, he follows the valley of the Saskatchewan, and crossing the Rocky Mountains by the Vermilion Pass, which lies between the upper portions of the Southern Saskatchewan and the Kutanie, a tributary of the Columbia, he enters the District of Columbia. The eastern half is very mountainous; but the greatest diversity of soil is met with in this province, lake, mountain, forest, marsh, and prairie frequently alternating.

History.

1. Who were the earliest traders with this island? To what part of it, and for what articles did they come?

The Phœnicians were the first to introduce this island to the notice of the civilized world. Several centuries before the Christian era they fetched tin from the Scilly Isles, which Herodotus, the earliest writer who mentions our country, calls Cassiterides (tin-islands).

2. What resistance was offered by our native tribes to the Roman invaders? Give some account of Julius Agricola, his policy and exploits.

In 54 B.C. Julius Cæsar was opposed by Cassivellaunus, who led the united British tribes against the Romans. In A.D. 43 the Britons of the centre, east, and west, headed by the south Welsh (Silures) maintained a fierce resistance under Caradoc (Caractacus), against the Roman advance. In A.D. 47 Ostorius Scapula, after a strong resistance by the Iceni and Brigantes, captured Caractacus. In A.D. 61 Suetonius Paulinus, on his march against Mona (Anglesea), had a tremendous battle with the Druids, and during his absence from London, Boadicea raised a revolt, and massacred many thousands of Roman settlers.
The great epoch in the history of the Roman conquest of Britain is the command of Julius Agricola, from A.D 78 to 85. It was his fleet that sailed round Britain, and thus first proved it to be an island. He not only subdued, but did his best to civilize. As to the subduing of it, he put down all resistance, defeated the Caledonians in a great battle at the Grampian Hills, and built a chain of forts from the Firth of Forth to the Firth of Clyde.

3. Write down names and dates of our sovereigns from Edmund Ironside to Edward the Confessor, and explain how the Saxon dynasty came to an end.

		A.D.	A.D.
Edmund II. (Ironside)	reigned from	1016	to 1017.
Canute	,, ,,	1017	,, 1036.
Harold I.	,, ,,	1036	,, 1039.
Hardicanute	,, ,,	1039	,, 1041.
Edward (Confessor)	,, ,,	1041	,, 1066.

The Saxon dynasty came to an end on the field of Senlac, by the death of Harold II., who was defeated and slain by William of Normandy, 1066.

Composition.

Write from memory the substance of the passage read to you once by the Inspector.

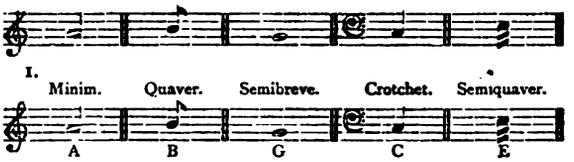
'The intense chill of the north wind in the desert of Central Asia,' says a traveller, 'cannot be imagined by any one who has not wintered there. The cattle, though abundantly supplied with warm clothing, suffer much at night from the wind striking their legs and penetrating to their belly and haunches. The breath clings in icicles to the pillow and bed-clothes within the tent. Towels hung up to dry stiffen into ice, and water freezes

hard, in a close room, within three feet of a charcoal fire. All the rest of my head and face, when I travelled, was snugly packed in fox's fur, but it was very difficult to preserve the nose from being frost-bitten. With fingers of a violet colour, and stiff as sealing-wax, I had to form an arch under which the heat of the breath collected and thawed the nose.'

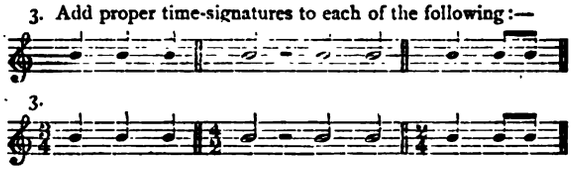
Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write above each of the following notes its value-name (semibreve, &c.); and below each its pitch-name (C, D, E, &c.):—

2. Write down the minor thirds contained between the notes of the scale of C :—

3. Add proper time-signatures to each of the following:—



TONIC SOL-FA NOTATION.

1. Write a six-pulse tone, using three-pulse measures.

1. | l :— :— | — :— :— ||

2. Write down the minor thirds contained between the notes of the common scale.

2. *Ray* and *fah*; *me* and *soh*; *lah* and *doh*^{1}; *te* and *ray*^{1}.

3. Write the following an octave higher :—

s m l t_1 f m r l_1 t_1 d

3. s^1 m^1 l^1 t f^1 m^1 r^1 l t d^1

SECOND YEAR.

Pupil Teachers at end of Second Year.

Three hours and a half allowed for this Paper.

MALES.

Euclid.

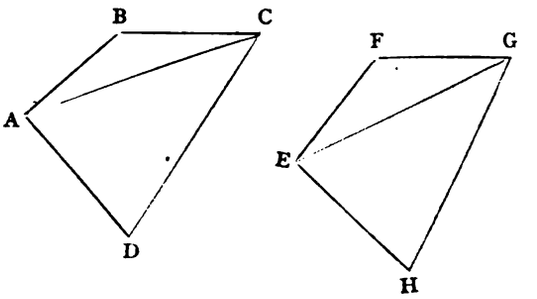
All generally understood abbreviations for *words* may be used.

1. If two quadrilaterals have three sides of the one equal to three sides of the other, and likewise the angles contained by the equal sides equal in each, the figures shall be equal in every respect.

Let ABCD, EFGH be two quadrilaterals having the three sides AB, BC, CD respectively equal to the three, EF, FG, GH, and likewise $\angle$s ABC, BCD respectively equal to the $\angle$s EFG, FGH; then the figures ABCD, EFGH shall be equal in every respect—that is, the remaining side AD=EH, the $\angle$ ADC= $\angle$ EHG, and $\angle$ BAD= $\angle$ FEH.

Join AC, EG; then by Prop. 4, Bk. I., the $\triangle$ ABC= $\triangle$ EFG in every respect, and $\therefore$ $\angle$ BCD= $\angle$ FGE, but the whole $\angle$ BCD =whole $\angle$ FGH (Hyp.) and $\therefore$ the remainder ACD=remainder EGH, and the base AC=the base EG.

Again, because AC=EG, and CD=GH (Hyp.) and the included $\angle$ ACD= $\angle$ EGH, $\therefore$ by Prop. 4, Bk. I., the $\triangle$s ACD, EGH are equal in every respect, and $\therefore$ AD=EH and the $\angle$ ADC=EHG, and the $\angle$ CAD= $\angle$ GEH.



To each of the $\angle$s CAD, GEH add respectively the equal angles BAC, FEG and the whole $\angle$ BAD=the whole $\angle$ FEH. Therefore the figures are equal in every respect, for the remaining side AD=EH, the $\angle$ ADC= $\angle$ EHG, and the $\angle$ BAD = $\angle$ FEH.

2. To draw a straight line perpendicular to a given straight line of unlimited length, from a given point without it.

Prop. 12, Bk. I.

3. To make a triangle of which the sides shall be equal to three given straight lines, but any two whatever of these must be greater than the third.

Prop. 22, Bk. I.

Arithmetic.

FEMALES.

1. A can dig a garden in 5 days, B in 6 days, and C in 7 days. In what time will all three working together finish it? Find also the time in which A and B together, A and C together, and B and C together, could respectively finish it.

In 1 day A does $\frac{1}{5}$; B, $\frac{1}{6}$; and C, $\frac{1}{7}$.

$\therefore$ A, B, and C do together $\frac{1}{5}+\frac{1}{6}+\frac{1}{7}$ or $\frac{42+35+30}{210}$

$=\frac{107}{210}$ in 1 day.

And $\therefore$ they will do the whole in $\frac{210}{107}$ or $\underline{1\frac{103}{107}\text{ day}}$. Ans.

A+B do $\frac{1}{5}+\frac{1}{6}$ or $\frac{11}{30}$ in 1 day; the whole in $\underline{2\frac{8}{11}\text{ days}}$. Ans.

B+C ,, $\frac{1}{6}+\frac{1}{7}$ or $\frac{13}{42}$,, ,, ,, $\underline{3\frac{3}{13}\text{ days}}$. Ans.

A+C ,, $\frac{1}{5}+\frac{1}{7}$ or $\frac{12}{35}$,, ,, ,, $\underline{2\frac{11}{12}\text{ days}}$. Ans.

2. Reduce $\frac{8}{9}$ of half-a-crown to the fraction of £1.

$$\frac{\frac{8}{9}\text{ of }30\text{d.}}{240\text{d.}}=\frac{30\times 8}{240\times 9}=\frac{1}{9}.\quad\text{Ans.}$$

3. After spending $\frac{3}{5}$ of my money, I find that $\frac{4}{7}$ of the remainder is 1s. 9d.; what had I at first?

After spending $\frac{3}{5}$ there remains $\frac{2}{5}$.

$\frac{4}{7}$ of $\frac{2}{5}=\frac{8}{35}$=21d. or 21d.=$\frac{35}{8}$ of the whole.

$\therefore$ the whole=21d.$\div\frac{35}{8}=\frac{21\times 35}{12}=\frac{245}{4}$d.

$=61\frac{1}{4}$d.$=\underline{5\text{s. }1\frac{1}{4}\text{d.}}$ Ans.

4. Reduce $\frac{1}{7}$ to six decimal places.

$$\frac{1}{7}=\frac{1\cdot000000}{7}=\underline{\cdot142857\ldots\ldots}\quad\text{Ans.}$$

Grammar.

MALES AND FEMALES.

1. *She*, good *cateress*,
Means her provision *only* to the *good*,
That live according to her sober laws,
And holy *dictate* of *spare* temperance.

COMUS.

Analyse the above, parsing the words in italics.

2. What Latin prefixes and terminations do you see in it?

3. Paraphrase the passage. ('She' refers to 'Nature.')

ANALYSIS.

Sentence.	Kind.	Subject.	Predicate.	Completion.	Extension.	Connective.
1. Sh. good cateress, means her provision only to the good,	Principal	she, good cateress,	means	her provision (*dir. obj.*) to the good (*indir obj.*)	only (degree)	
2. That live according to her so'er laws, and holy dictate of spare temperance.	Subord. adjective to 'the good' (in 1)	that	live		according to, etc., ... temperance (*manner*)	that

PARSING.

She—demonstr., 3rd pers., pron., fem., referring to 'Nature,' sing., nom., subj. of 'means.'
cateress—com. noun, fem., sing., nom., in apposition with 'she.'
means—irreg. trans. verb, *mean*, *meant*, *meant*, indic., pres., indef., 3rd pers., sing., agr. with 'she.'
only—adv. of degree, mod. 'means.'
good—adj., used as a noun, collective, plur., mas. or fem., obj., gov. by prep. 'to.'
that—simple rel. pron., referring to 'the good,' 3rd pers., mas. or fem., plur., nom., subj. of 'live.'
live—reg. intrans. verb, indic., pres., indef., 3rd pers., plur., agr. with 'that.'
according to—prep. phrase, relating to 'live' and 'laws,' and gov. the latter in obj. case.
dictate—abstr. noun, neut., sing., obj., gov. 'according to.'
spare—adj., pos. deg., qual. 'temperance.'

2 The Latin prefixes in the above are: 'pro' in 'provision,' and 'ac' (ad) in 'according.'

The affixes are 'ion' in 'provision,' 'ate' in 'dictate,' and 'ance' in 'temperance.'

3. Nature, like a thrifty provider, so disposes her blessings that none are expected to have the full enjoyment of them but those who are guided by the rules of temperance and sobriety.

4. How is the prefix 'in' (meaning 'not') modified in composition? Give instances.

'In' (meaning 'not') is modified into *i*, *il*, *im*, *ir*: as, *ignoble*, *ignore*; *il*literate, *il*legal; *im*maculate, *im*pure; *ir*rational, *ir*regular. 'In' often interchanges with 'un,' as *in*certain, *in*justice, *un*just.

Geography.

Answer either Q. 2 or Q. 3, not both.

1. Draw a map of Spain and Portugal; and describe, as fully as you can, *referring to your map for illustration*, the water-partings and river-basins of that peninsula.

N.B.—Insert the lines of latitude and longitude.

The peninsula of Spain and Portugal is crossed by long mountain-ranges parallel to each other, which run from west to east, and which support between them the table-lands that are also the valleys of rivers flowing from east to west. Thus the Cantabrian Mts. and the Sierra Guadarama enclose the valley of the Douro; the Sierra Guadarama and the Sierra Toledo shut in the high and rocky basin of the Tagus. Again, the Sierra Toledo and the Sierra Morena form the rim of the Guadiana basin; while the Sierra Morena and the Sierra Nevada bound the valley of the beautiful Guadalquivir. The triangular valley of the Ebro is enclosed by the Pyrenees on the north, and by the steep sides of the eastern end of the central table-land.

2. Between what degrees of latitude and longitude does Russia in Europe lie? Explain exactly what is meant by saying that any place is in a certain *degree* of latitude and longitude. What are the most northerly, and the most southerly, points of that country?

European Russia lies between lats. 40° 20′ and 70° N., and between long. 17° 50′ and 67° E.

The degree of latitude and longitude gives us the exact locality of a place on the surface of the earth. The degree of latitude tells us how far the place is north or south of the Equator, and the degree of longitude how far the place lies east or west of our First Meridian, which passes through Greenwich Observatory. The degree is divided into 60 minutes, and the minute into 60 seconds.

The most northerly point of the mainland is east of Tana Fiord, in Lapland, and the most southerly is Cape Apsheron, the eastern extremity of the Caucasus, on the Caspian Sea.

3. Say what you know about the cultivation of rice, indigo, tea, and cotton in British India, and distinguish the different parts of that country which are suitable for each of these articles.

Rice, which forms the staple food of the inhabitants, grows on the bank of the lower Ganges, and all around the sea-coast. Its cultivation requires an immense quantity of moisture, and it grows best in fields which are, or can be, inundated. It is generally sown while the waters cover the land. The plants are also grown from cuttings, which are steeped in water first and then placed in the soil or mud brought down by the flooded river. When six inches high these are planted into rows one foot apart.

Indigo is chiefly produced in Bengal, in the delta of the Ganges. This plant is a native of India, from which country it takes its name. To obtain the dye, the plants are cut down when they begin to flower, and are steeped in water until they slightly ferment. When the fermentation ceases, the water is drawn off and violently agitated. It is then allowed to settle, and a thick sediment forms at the bottom, which sediment drained and dried is the indigo of commerce. The seeds are sown in spring at the rate of about a dozen pounds per acre. The plants grow rapidly, blossom in about three months, are cropped, and allowed to grow again. They are cropped a second, a third, and sometimes even a fourth time, when the process given above is gone through to procure the colouring matter.

Tea is grown in the moist, warm valleys of the Himalaya mountains, and particularly in Assam, where the plant was found growing wild. This plant is a hardy evergreen, from three to six feet in height. The plant is propagated by seeds, on light, strong ground, and requires an abundance of light and air. The plants are sown five or six in a hole in rows four or five feet asunder. The first crop is gathered when the plant is three years old.

Cotton is indigenous to India, and grows chiefly in the uplands of N. and W. Coimbatore and Mysore are famous for their crops, as also Guzerat and Scinde. Another district is the *Doab*, or country between the Jumna and Ganges; and it is also grown to a large extent in the valleys of the Godavery and Kistna. A large quantity of the cotton produce of India is consumed in the native manufactures; but there is still an immense quantity for export. During the last twenty years the quantity shipped to England has more than doubled.

Arithmetic.

MALES.

Two hours and a half allowed.

1. If the 4d. loaf weighs 2¼ lb. when wheat is 45s. per qr., how much ought the 6d. loaf weigh when wheat is 54s. per qr.?

$$\left.\begin{matrix}4\text{d.} : 6\text{d.} \\ 54\text{s.} : 45\text{s.}\end{matrix}\right\} :: 2\tfrac{1}{4}\text{ lb.} : ?$$

$$\frac{36\text{ oz.} \times 6 \times 45}{4 \times 54} = 45\text{ oz.} = \underline{2\text{ lb. }13\text{ oz.}}\text{ Ans.}$$

2. What principal will amount to £1310 8s. 7½d. in 2 years at 4½ per cent. per annum, compound interest?

(*a*) Compound interest on £100 for 2 yrs. at 4½ p.c. = £9·2025
Amount of ,, ,, = 109·2025
(*b*) £1310 8s. 7½d. = £1310·43
(*c*) ∴ £109·2025 : £1310·43 :: £100 : Principal.

$$\frac{£100 \times 1310{\cdot}43}{109{\cdot}2025} = \frac{£131043}{109{\cdot}2025} = \underline{£1200}.\text{ Ans.}$$

3. A tradesman buys £520 worth of goods, and sells ¾ of them at a gain of 15 per cent., and the rest at a loss of 5 per cent.; what is his average gain per cent. and his total gain on the goods?

$\frac{3}{4}$ of £520 = £390

	£	s.
Selling price of goods worth £390 = £390 × $\frac{115}{100}$ =	448	5
,, ,, £130 = 130 × $\frac{95}{100}$ =	123	5
Price of goods sold =	572	0
Prime cost of ,, =	520	0
Total gain on £520 =	52	0

∴ £520 : £100 :: £52 : £10 gain p.c. Ans.

4. A man invests money in the 3 per cents. at 97⅜, and on their rising to 98⅛ he sells out and gains £24; how much money did he invest? (Omit brokerage.)

£98⅛ − £97⅜ = £¾, the gain on every £97⅜.

∴ £¾ : £24 :: £97⅜ : Money invested.

$$£97\tfrac{3}{8} \times \frac{24}{\frac{3}{4}} = \frac{799 \times 24 \times 4}{8 \times 3} = £3116.$$ Ans.

History.

MALES AND FEMALES.

1. What were the crusades? Name any English princes who took part in them, and mention benefits they are said to have produced.

In 1095 A.D. a council of the Church held at Clermont resolved that an attempt should be made to rescue the city of Jerusalem from the hands of Mahommedan infidels, called Saracens, who held possession of it. A religious enthusiast, Peter the Hermit, journeyed through Europe, and called on the nobles, knights, and kings to deliver the sepulchre of Christ from the infidels. In 1096 the first expedition was formed, and which, from the *cross* sewn upon the dress of those who joined it, has been called a *crusade*.

The English princes who took part in them were, Robert, eldest son of William I., Richard I., and Edward, afterwards Edward I.

The benefits accruing from them were the check given to the tide of Mahommedan conquest in the direction of Europe, making people of one country acquainted with those of another, and introducing into Europe the arts, literature, civilisation, and commerce of the East.

2. What sovereign reigned between Henry III. and Edward II.? Show briefly the characteristics of the three reigns.

Edward I. reigned between Henry III. and Edward II. The reign of Henry III. is characterised by the confirmation of Magna Charta, and by the summoning of the first regular parliament; that of Edward I. by his conquest of Wales, his wise and patriotic management of affairs in England, and by his obstinate attempts to conquer Scotland, which he invaded and overran; and that of Edward II., by the timidity and effeminacy of the king, who allowed himself to be governed by favourites, and was unable to carry out the designs of his father, by the assertion of Scottish independence under Bruce, and by the revolt of the English against a monarch who disgusted them, and who was finally murdered in Berkeley Castle, 1327.

3. Who was the consort of Richard III.? Sketch her career, and explain the importance attached at this time to the hand of Elizabeth of York.

The consort of Richard III. was Anne Neville, younger daughter of the Earl of Warwick, styled the "king-maker." She was the wife of Prince Edward, son of Henry VI. and Margaret of Anjou; but she was left a widow by the cold-blooded murder of her husband at Tewkesbury, 1471, by the Dukes of Gloucester and Clarence. On the Duke of Gloucester's proposing to marry the young widow, Clarence concealed her in London, but Gloucester found her and carried her off to the Sanctuary of St. Martin's. On application to the king and Council he was permitted to marry her, and the estates of her father were shared between her husband and Clarence, who had married her sister Isabella. When Gloucester became king she was crowned as his queen in Westminster. On her death Richard had some designs of marrying Elizabeth, who represented the House of York, she being considered to have the best claim on the throne of any then living.

Teaching.

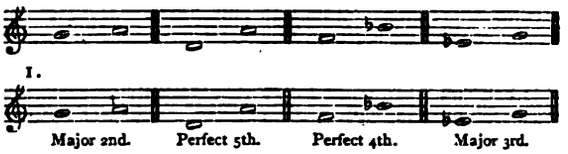
How do you deal with hard words which occur in the course of a reading lesson; and how can you make sure that they are properly spelled and understood by your class?

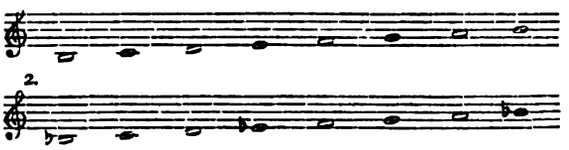
The hard words occurring in the course of the lesson should be written or printed on the black-board and divided into syllables. To make sure that they are properly spelled and understood by the class these words should be pronounced in syllables by the children, explained by the teacher as to meaning (and derivation, if the class is an advanced one). Turning the board, let the words be dictated and written on slates to test whether the children have mastered their difficulties; or let them be copied on slates and brought up at next day's lesson. It is a good plan to note the hard words that occur from time to time, and give them out as a revising lesson.

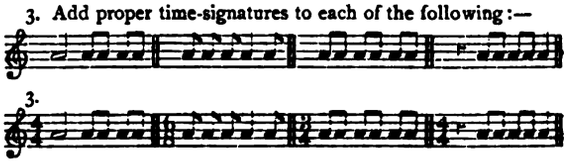
Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write below each of the following intervals its name (minor third, &c.):—

2. Write the scale of B flat, placing the necessary flats before the notes to be flattened.



3. Add proper time-signatures to each of the following:—

TONIC SOL-FA NOTATION.

1. What is the interval (major third, &c.) (*a*) between *soh* and *lah*; (*b*) between *ray* and *lah*; (*c*) between *doh* and *fah*; (*d*) between *doh* and *me*?

1. (*a*) Major 2nd; (*b*) Perfect 5th; (*c*) Perfect 4th; (*d*) Major 3rd.

2. What is the mental effect (*a*) of *te*; (*b*) of *lah*?

2. (*a*) Piercing; (*b*) Mournful.

3. Write (*a*) the pulse signs for a four-pulse measure; (*b*) nine-pulse measure.

3. Primary Form. (*a*) | : | : ‖ Primary Form. (*b*) | : : | : : | : : ‖

THIRD YEAR.

Pupil Teachers at end of Third Year, *if apprenticed on or after 1st May,* 1878; **and Pupil Teachers at end of Fourth Year,** *if apprenticed before that date.*

Three hours and a half allowed.

Euclid.

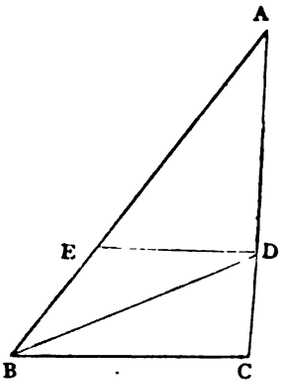
[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including Question 1, *if you can.*

MALES.

1. AB is the hypothenuse of a right-angled triangle ABC. BD is drawn bisecting the angle B and meeting AC at D, and DE perpendicular to AC meets AB at E. Prove that the triangle EDB is isosceles.

Since ED is perp. to AC, it is also ‖ to BC (I. 28) and ∴



∠EDB = ∠DBC (I. 29), but ∠DBC = ∠EBD, ∴ ∠EDB = ∠EBD and ∴ △EBD is isosceles (I. 6). Q. E. D.

2. If a straight line falling on two other straight lines make the alternate angles equal to each other; these two straight lines shall be parallel.

Prop. 27, Bk. I.

3. Equal triangles upon equal bases in the same straight line, and towards the same parts, are between the same parallels.

Prop. 39, Bk. I.

Algebra.

Answer two Questions.

1. A starts for a walk at the rate of 4 miles an hour, and after 15 minutes B follows him at the rate of $4\frac{3}{4}$ miles an hour; when and where will he overtake A?

(*a*) Let x = number of miles gone by both

then $\frac{x}{4}$ = time A takes in hours.

and $\frac{x}{4\frac{3}{4}}$ = ,, B ,, ,, ,,

$$\therefore \quad \frac{x}{4} - \frac{x}{4\frac{3}{4}} = \tfrac{1}{4} \text{ hour.}$$

$$\frac{x}{4} - \frac{4x}{19} = \tfrac{1}{4}$$

$$19x - 16x = 19$$

$$3x = 19$$

$$x = \underline{6\tfrac{1}{3}} \text{ miles. Ans.}$$

$$\frac{6\frac{1}{3}}{4\frac{3}{4}} = \tfrac{4}{3} = \underline{1 \text{ hour } 20 \text{ min.}} \quad \text{Ans.}$$

2. Square $1 - 2x + 3x^2 - 2x^3 + x^4$, and resolve $(4x - 7y)^2 - 9y^2$ into factors.

(*a*)

$$(1 - 2x + 3x^2 - 2x^3 + x^4)^2 = 1 + 2(-2x + 3x^2 - 2x^3 + x^4) + 4x^2 - 4x(3x^2 - 2x^3 + x^4) + 9x^4 + 6x^2(-2x^3 + x^4) + 4x^6 - 4x^3(x^4) + x^8$$

$$= 1 - 4x + 6x^2 - 4x^3 + 2x^4 + 4x^2 - 12x^3 + 8x^4 - 4x^5 + 9x^4 - 12x^5 + 6x^6 + 4x^6 - 4x^7 + x^8$$

$$= \underline{1 - 4x + 10x^2 - 16x^3 + 19x^4 - 16x^5 + 10x^6 - 4x^7 + x^8}. \quad \text{Ans.}$$

NOTE.—*The square of a polynomial consists of the square of each term, together with twice the product of each term by the sum of all the terms which follow it.*

(*b*) $(4x - 7y)^2 - 9y^2 = \{(4x - 7y) + 3y\}\{(4x - 7y) - 3y\}$

$$= (4x - 4y)(4x - 10y)$$

$$= \underline{8(x - y)(2x - 5y)}. \quad \text{Ans.}$$

3. Solve the equations:—

(1) $\frac{2}{3}(x - 5) - \frac{3}{11}(x - 13\frac{1}{2}) = 5 - \frac{1}{2}(7 - x)$.

(2) $\frac{17}{6x + 17} - \frac{10}{3x - 10} = \frac{1}{1 - 2x}$

(1) $\frac{2}{3}(x - 5) - \frac{3}{11}(x - 13\frac{1}{2}) = 5 - \frac{1}{2}(7 - x)$

$$110(x - 5) - 45\left(\frac{3x - 40}{3}\right) = 825 - 33(7 - x)$$

$$110x - 550 - 45x + 600 = 825 - 231 + 33x$$

$$110x - 45x - 33x = 825 - 231 - 600 + 550$$

$$32x = 544$$

$$x = \underline{17}. \quad \text{Ans.}$$

(2) $$\frac{17}{6x + 17} - \frac{10}{3x - 10} = \frac{1}{1 - 2x}$$

$$51x - 170 - 60x - 170 = \frac{18x^2 - 9x - 170}{1 - 2x}$$

$$-9x - 340 = \frac{18x^2 - 9x - 170}{1 - 2x}$$

$$18x^2 + 680x - 9x - 340 = 18x^2 - 9x - 170$$

$$680x = 170$$

$$x = \underline{\tfrac{1}{4}}. \quad \text{Ans.}$$

Mensuration.

Show by an example that if a square and a rectangle have equal perimeters, the area of the square exceeds the area of the rectangle by the area of a square whose side is half the difference of the sides of the rectangle.

Let the side of the square = 4, then perimeter = 16.

Then the rectangle may be 6×2 to equal perimeter of square.

∴ If the above theorem be correct the area of the square (which is $4^2 = 16$), must be greater than the area of the rectangle (which is $6 \times 2 = 12$) by the area of a square whose side is half the difference of the sides of the rectangle (which is $\sqrt{(\frac{1}{2} \text{ of } 6 - 2)}$ or $\underline{2}$).

$(4)^2 - (6 \times 2) = 4$, area of a square.

Now the side of this square must be $\sqrt{4}$ or 2, which is equal to the diff. of the sides of rect. Q. E. D.

FEMALES.

Arithmetic.

1. In a school of 200 children there are four classes, of which the first contains ·24, the second ·36, and the third ·18 of the whole; of how many does the fourth class consist?

$$\cdot 24 + \cdot 36 + \cdot 18 = \cdot 78 \text{ or } \tfrac{78}{100}.$$

∴ the fourth class consists of $\frac{22}{100}$ of 200 or $\underline{44}$. Ans.

2. In a school of 100, the ages of 4 children average 13·5, of 16 others 12·375, of 34 others 11 years, the average of the whole is 10·575 years; find the average age of the remaining children.

The ages of	4 =	(collectively)	13·5 × 4 =	54
,,	16 =	,,	12·375 × 16 =	198
,,	34 =	,,	11 × 34 =	374
The ages of	54 =	,,	=	626
,,	100 =	,,	10 575 × 100 =	1057·5
∴ ,,	46 =	,,		431·5

Average age of the 46 = $\frac{431 \cdot 5}{46} = \underline{9 \cdot 38\ldots}$ Ans.

3. If a team can plough 4·6 acres a day, how long will they take to plough 63·25?

4·6 ac. : 63·25 ac. :: 1 day : ?

$$\frac{1 \text{ da.} \times 63 \cdot 25}{4 \cdot 6} = \underline{13 \cdot 75} \text{ days.} \quad \text{Ans.}$$

4. If 5 horses consume 7 bus. 2 pks. of oats in 11 days, how much will 22 horses consume in 10 days?

$$\left.\begin{matrix} 5 \text{ horses} : 22 \text{ horses} \\ 11 \text{ days} : 10 \text{ days} \end{matrix}\right\} :: 7\tfrac{1}{2} \text{ bush.} : ?$$

$$\tfrac{15}{2} \text{ bush.} \times \tfrac{22}{5} \times \tfrac{11}{11} = \frac{15 \times 22 \times 10}{2 \times 5 \times 11} = \underline{30} \text{ bush.} \quad \text{Ans.}$$

Grammar.

MALES AND FEMALES.

1.

Morning fair
Came forth, with *pilgrim steps* in amice *gray*,
Who with her radiant finger *still'd* the *roar*
Of thunder, *chased* the clouds, and *laid* the winds
And grisly *spectres which* the fiend had raised.

MILTON.

Analyse the foregoing, parsing the words in italics.

2. Paraphrase the passage. ('Amice' means a pilgrim's robe.)

ANALYSIS.

Sentence.	Kind.	Subj.	Predicate	Completion.	Extension.	Connective.
(1) Morning fair came forth with pilgrim steps in amice gray	Principal	Morning fair	came		forth (*place*), with pilgrim steps in amice gray (*manner*)	
(2) Who with her radiant finger still'd the roar of thunder	Principal.	who	stilled	the roar of thunder	with her radiant finger (*instrument*)	who =and she
(3) (who) chased the clouds	Principal.	(who)	chased	the clouds		(who =and she)
(4) and (who) laid the winds and grisly spectres	Principal.	(who)	laid	the winds and grisly spectres		and
(5) which the fiend had raised	Adj. to (4)	the fiend	had raised	which		which

PARSING.

Fair—adj. qual. 'morning.'
pilgrim—noun used as an adj., qual. 'steps.'
steps—com. noun, neut., plur., obj., gov. by 'with.'
gray—adj., qual. 'amice.'
who—simple rel., referring to 'morning' (personified), 3rd pers., sing., fem., nom., subj. of 'still'd.'
still'd—reg. trans. verb, indic., past indef., 3rd pers., sing., agr. with 'who.'
roar—abstr. noun, neut., sing., obj. gov. by 'still.'
chased—reg. trans. verb, indic., past, indef., 3rd pers., sing., agr. with ('who').
laid—irreg. trans. verb, *lay, laid, laid*, indic., past, indef., 3rd pers., sing., agr. with ('who').
spectres—com. noun, conveying either an idea of mas. or fem., plur., obj., gov. by 'laid.'
which—simpl. rel., referring to both 'winds' and 'spectres,' mas., fem., or neut., obj. gov., by 'had raised.'

2. The fearful storms which raged during the night, and which seemed from their violence to have been raised by supernatural agency, quieted down at the dawn of day, and the skies gradually assumed a more cheerful aspect.

3. Point out the prefix in each of the following words :—Spend, enormous, symmetry, accede, pellucid, ignoble, co-agulate, suppress, combustion.

The prefixes are :—*s* for *dis* in 'spend'; *e*=*ex* in 'enormous'; *sym*=*syn* in 'symmetry'; *ac*=*ad* in 'accede'; *pel*=*per* in 'pellucid'; *i*=*in* in 'ignoble'; *co*=*con* in co-agulate; *sup*=*sub* in 'suppress,' and *com*=*con* in 'combustion.'

Geography.

1. Give 'Notes of a Lesson' on 'The Native Tribes of Africa,' distinguishing the different parts of the country where each of them is found, and describing, as for children, the features, appearance, and habits of each.

NATIVE TRIBES OF AFRICA.

NEGROES.—(1) *Foolahs*. (2)' *Mandingoes*. (3) *Jaloofs*—spread over Senegambia, western Soudan, and Upper Guinea. (1) Most deserving of attention; superior in intelligence and civilisation; have a noble bearing; fine, regular features; comparatively light complexion resembling the rich brown of the Spaniards; lead a nomadic life, and have some manufactures and commerce. (2) Are also a civilized race, though inferior to (1); of a deep black colour; woolly hair; thick lips, broad flat nose, and tall powerful frame; their leading men read and write Arabic; engaged in manufactures and commerce. (3) Live in the deltas of the Gambia and Senegal; are mild, hospitable, and trustworthy, but are physically of a low type; live by hunting; Soudan, the true home of the Negro, where he is by no means the miserable-looking and degenerate creature which he seems to be when subjected to the bondage and inhuman treatment of the white man. In Guinea the natives are generally in a low state of civilisation—pagans—slavery and polygamy prevail—and human sacrifices are practised by several tribes.

HOTTENTOTS.—Confined to the S.W. angle of Africa, extending from Cape Negro to Cape Agulhas, and as far inland as the Kalahari desert; are a nomadic people—never cultivate the soil—nor rear a domestic animal—get subsistence from roots, beans, and the flesh of game—form one of the most degraded sections of humanity, and their features are hideous.

KAFFIRS.—Occupy the rest of South Africa, living N. and E. of the Hottentots, and in some places extend from sea to sea. On the western side of the Continent, extending from the Equator to Cape Negro, and on the eastern from Cape Colony to the borders of the Somali country. They are described as a fine athletic race, frequently as handsome as Europeans; till the ground and engage in agriculture.

NOTE.—*Map of Africa, or sketch on blackboard; explanations to be given as lesson proceeds; all proper names to be written, spelt, and pronounced.*

2. Daw a full map of Turkey in Asia. Insert the lines of latitude and longitude.

3. Name, in order, the great rivers of Asia, and briefly describe their courses.

3. RIVERS OF ASIA.

FLOWING INTO THE PACIFIC OCEAN.

River	Rises in	Flows	Through	Falls into
Meinam.	Borders of China.	S.	Siam.	Gulf of Siam
Mekong.	"	S.	Annam.	Chinese Sea.
Yang-tse-Kiang.	Tibet.	E.	Central China	Yellow Sea.
Hoangho	"	E.	Northern China.	" "
Amoor, or Saghalien.	North of Mongolia.	E.	S.E. of Siberia, and north of Manchooria.	Gulf of Tartary.

FLOWING INTO ARCTIC OCEAN.

Lena.	W. of Lake Baikal.	N.E. and N.	Eastern Siberia	Arctic Ocean
Yenisei.	Mongolia.	N.	Central "	Bay of Yenisei.
Obi.	Altai Mounts.	N.W. and W.	Western "	Gulf of Obi.

FLOWING INTO THE INDIAN OCEAN,

Euphrates—Tigris.	Armenian Mounts.	W. and S.E. S.E.	East of Turkey.	Persian Gulf
Indus.	Tibet.	N.W. and S.	Tibet and India.	Arabian Sea.
Ganges.	Himalayas	S.E.	India.	Bay of Bengal.
Brahmaputra	Tibet.	E. and N.	Tibet and India	Bay of Bengal.
Irrawady.	Borders of Tibet.	S.	Burmah and Pegu	Gulf of Martaban.
Saluen.	Borders of Tibet.	S.	Burmah and Pegu	Gulf of Martaban.

SECOND PAPER.

Two hours and a half allowed.

Arithmetic.

MALES.

1. A grocer by selling tea at 2s. 9d. per lb., gains 12 per cent.; what did the tea cost him per cwt.?

1 cwt. at 2s. 9d. per lb. = $2\frac{3}{4}$s. × 112 = 308s.
∴ 112 : 100 :: 308s. : Cost per cwt.

$$\frac{308\text{s.} \times 100}{112} = 275\text{s.} = \underline{£13\ 15\text{s.}}\ \text{Ans.}$$

2. Define discount. Find the (true) discount on a bill of £401 16s. due 219 days hence at 4 per cent. per annum.

Discount is an allowance or deduction according to the rate of interest for money advanced before it is due. Bankers calculate interest on the sum drawn for in a bill from the time of discounting it till it becomes due. This discount is greater than the *true discount* by the interest of the latter for the time that the bill has still to run.

Interest of £100 for 219 days at 4 p. c. $= \frac{4 \times 219}{375} = £2\frac{2}{5}$
Amount " " " $= 102\frac{2}{5}$.
∴ $102\frac{2}{5} : 2\frac{2}{5} :: £401\frac{1}{2} :$ True discount;

$$£401\tfrac{1}{2} \times \frac{2\frac{2}{5}}{102\frac{2}{5}} = \frac{2009 \times 12}{5 \times 512} = £\frac{0.0.37}{0.4.0} = \underline{£9\ 8\text{s.}\ 4\tfrac{1}{5}\text{d.}}\ \text{Ans.}$$

3. How much stock must I sell out of the 3 per cents. at 99¼ to purchase £1584 stock in 4 per cent. railway stock at 126¾, brokerage being charged in each case?

99 : 126¾ :: £1584 : Stock to be sold.

$$£1584 \times \frac{126\frac{3}{4}}{99} = \frac{1584 \times 1015}{792} = £\underline{2010}. \quad \text{Ans.}$$

4. A number of men at a tavern spent as many farthings each as there were men, and the sum spent was £1 10s. 1d. How many were there?

No. of men × no. of farthings = £1 10s. 1d.
" " " = 1444 farthings.
but no. of men = no. of farthings.
∴ $\sqrt{1444}$ = no. of men = $\underline{38}$. Ans.

History.

MALES AND FEMALES.

1. When did the English begin to found colonies? Mention instances and enumerate the benefits of the measure.

The foundation of the Colonial Empire of Great Britain must be dated from the time of Henry VII., when John and Sebastian Cabot discovered Newfoundland and Labrador, but no colony was attempted to be formed until the time of Queen Elizabeth. Sir Humphrey Gilbert led a company to Newfoundland in 1583 and took possession of the country, but no settlement was made. In 1584, Sir Walter Raleigh discovered Virginia, and next year he took out 108 colonists whom he settled at the mouth of the Roanoke. This was the first actual occupation of territory by English in America, but like several others it proved unsuccessful, and one really permanent was not effected till 1607 when James-town, on the river James, was founded. On Dec. 1st, 1620, the Pilgrim Fathers landed at New Plymouth and established the New England colony.

Originally the colonies formed an asylum to political and religious refugees, but at the present time one of the greatest advantages is that they furnish a home for thousands of poor who find it hard to live in their own country. Others are valuable as stations to shelter our fleet; others valuable as trading stations for collecting produce from the surrounding countries, or for distributing English goods; and some act as half-way houses to supply ships with water, provisions, or coal.

2. Sketch the character of Charles II. and describe the chief events of his reign.

Charles II. had few qualities which merited the love bestowed upon him by his subjects at his restoration. He had talents, easy good-temper, and the manners of an accomplished gentleman, but neither heart nor principles. So far as he had any religion, he was secretly a Roman Catholic; as a ruler, his inclination was towards a despotic monarchy; but he did not risk his crown by grasping at more power. He was resolved, as he used to say, 'not to go on his travels again,' and his main object in life was to be amused and to avoid trouble.

The chief events of his reign were the passing of the Corporation Act (1661); of the Act of Uniformity (1662); of the Conventicle Act (1664); and of the Five-Mile Act (1665); the Great Plague (1665); Dutch War and the Great Fire of London (1666); Treaty of Breda (1667); Triple Alliance (1668); Test Act (1673); Titus Oates' Plot (1678); Habeas Corpus Act, Bothwell Bridge, and Meal Tub Plot (1679); and Rye House Plot (1683).

3. Give dates of the queens who have reigned in England, with the names and nationality of their husbands.

QUEEN.				HUSBAND.
Mary I.	reigned from	1553	to 1558	Philip of Spain.
Elizabeth	"	1558	" 1603	None.
Mary II.	"	1689	" 1694	William of Orange (Holland).
Anne	"	1702	" 1714	George of Denmark.
Victoria	"	1837	"	Albert of Saxe Coburg and Gotha (Germany).

Teaching.

Write notes of a lesson on either (1) A lake, or (2) (for infants) The furniture of the schoolroom.

Notes of a lesson on a 'LAKE.'

Show sketch or picture of pond, or lake, and maps with lakes clearly shown.

DEFINITION.—A lake is water surrounded by land—water generally fresh—surplus water carried off by river (*show that a pond is a miniature lake and its stream like a river*).

WHERE FOUND.—Lakes most numerous in hilly countries; because there the valleys are most numerous; valleys collect the waters from the mountains.

EXAMPLES.—American lakes so large as to be called 'fresh-water seas,' Lake Superior the largest lake in the world; largest in Europe, Lake Ladoga in Russia; Cumberland lakes in England, small, but very beautiful, that part called 'Lake District'; Scotland, being mountainous, has more lakes than England, some of them surrounded with lofty mountains or with beautiful woods, reaching down to the water's edge; Loch Lomond, 'Queen of Scottish Lakes'; in Ireland, Lakes of Killarney are very beautiful, lying among the mountains of Cork.

USES.—Great resorts of pleasure-seekers—some of great use in commerce. (*Examples.*)

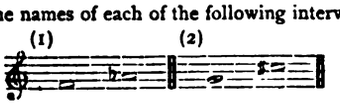
NOTE.—Lakes found having streams flowing into them but none flowing out; such usually salt (Caspian, Aral, and Dead Seas, really lakes).

Music.

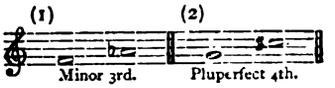
A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write the names of each of the following intervals :—

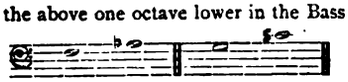


1. (1) (2)

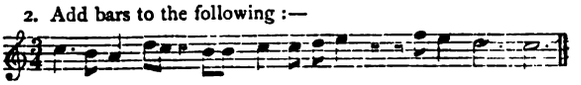


Minor 3rd. Pluperfect 4th.

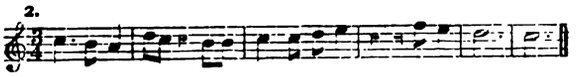
Transpose the above one octave lower in the Bass clef.



2. Add bars to the following :—



2.



3. Explain the following terms :—(*a*) *Da Capo*; (*b*) *Rallentando*; (*c*) *Legato.*

3. (*a*) Repeat from the beginning; (*b*) Slackening of the speed; (*c*) Smoothly, in a gliding manner.

TONIC SOL-FA NOTATION.

1. What is the interval (*a*) between *me* and *fah*; (*b*) between *ray* and *soh*; (*c*) between *me* and *te*? What is the name (*d*) for *fah sharp*; (*e*) for *te flat*?

1. (*a*) Minor 2nd; (*b*) Perfect 4th; (*c*) Perfect 5th; (*d*) *fe*; (*e*) *ta.*

2. What are the five kinds of measure commonly used?

2. Two-pulse; three-pulse; four-pulse; six-pulse; nine-pulse.

3. Explain the following terms :—(*a*) *Da Capo*; (*b*) *Rallentando*; (*c*) *Legato.*

3. (*a*) Repeat from the beginning; (*b*) Slackening of the speed; (*c*) Smoothly, in a gliding manner.

FOURTH YEAR.

Pupil Teachers at end of Fourth Year, *if apprenticed on, or after,* **1st May, 1878; and Pupil Teachers at end of Fifth Year,** *if apprenticed before that date.*

FIRST PAPER.

Three hours and a half allowed.

Euclid.

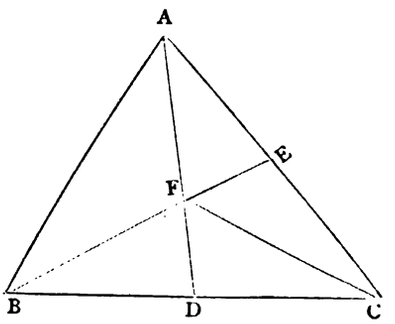
MALES.

[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including No. 1, *if you can.*

1. Find a point equidistant from the angles of a given triangle.

Let ABC be the given △, bisect AC in E, and BC in D, draw EF perp. to AC, and DF perp. to BC, and let EF, DF meet in F, F is the point required.



Because AE = EC, and EF is common to the two ∠s AEF, CEF, and ∠ AEF = ∠ CEF. ∴ (I. 4) AF = FC.

For a similar reason BF = FC, and ∴ the three straight lines AF, FC, FB are equal, and ∴ F is equally distant from the angles of the given △. Q. E. F.

2. If a straight line be bisected, and produced to any point; the rectangle contained by the whole line thus produced, and the part of it produced, together with the square on half the line bisected, is equal to the square on the straight line which is made up of the half and the part produced.

Prop. 10, Bk. II.

3. To describe a square that shall be equal to a given rectilineal figure.

Prop. 14, Bk. II.

Algebra.

Answer two Questions, including No 1., *if you can.*

1. How would you explain to a class the rule of signs in multiplication?

$(+a\times+b=+ab.\quad -a\times+b=-ab.\quad +a\times-b=-ab.$
$-a\times-b=+ab.)$

Because $+a\times+b$ means that $+a$ is to be added to itself as many times as there are units in b, then it equals $+ab$.

Because $-a\times+b$ means that $-a$ has to be repeated as often as there are units in $b=-a-a-a$, etc., b times, or $=-ab$.

Or, suppose that $b=3$, then $-a\times3$ indicates that $-a$ is to be repeated *three* times, that is, we have $-a-a-a$ or $-3a$ as the result. Thus

$$-a\times+b=-ab.$$

In the cases $+a\times-b=-ab$; and $-a\times-b=+ab$ the multiplier is a *negative quantity*, and thus the common arithmetical notion of multiplication is not applicable; we must therefore give by definition a meaning to the term in this case. Now we observe that when the multiplier is positive, the sign of the multiplicand is preserved in the product, thus we are led to adopt the following convenient guide: *When the multiplier is negative, perform the multiplication as if the multiplier were positive and change the sign of the product.* Hence we conclude immediately that

$$+a\times-b=-ab \text{ and } -a\times-b=+ab.$$

2. Find the cube root of $:-729x^3+2673x^2y+3267xy^2+1331y^3$. Ans.

$729x^3+2673x^2y+3267xy^2+1331y^3\ (9x+11y.$
$(9x)^3=729x^3$
$(9x)^2\times3+\{(3\times9x+11y)11y=\text{divisor}\quad 2673x^2y+3267xy^2+1331y^3$
$\therefore\ 243x^2+297xy+121y^2\times11y=\quad 2673x^2y+3267xy^2+1331y^3$

3. Solve the equations:—

$$\left.\begin{aligned}(1)\ \frac{2x}{3}+\frac{4y}{5}&=64\\ \frac{5x}{6}+\frac{9y}{10}&=77\end{aligned}\right\}$$

$$(2)\ \frac{48}{x+3}=\frac{165}{x+10}-5.$$

3. (1) $\frac{2x}{3}+\frac{4y}{5}=64$ or $50x+60y=4800$

$\frac{5x}{6}+\frac{9y}{10}=77$ or $50x+54y=4620$

$6y=180$

$y=30.$ Ans.

Hence $x=60.$ Ans.

$$(2)\ \frac{48}{x+3}=\frac{165}{x+10}-5.$$

$48x+480=165x+495-5x^2-65x-150$

$5x^2-52x=-135$

$x^2-\frac{52}{5}x=-\frac{135}{5}$

$x^2-\frac{52}{5}x+(\frac{26}{5})^2=\frac{676-675}{25}=\frac{1}{25}$

$x-\frac{26}{5}=\pm\frac{1}{5}$

$x=\frac{26}{5}\pm\frac{1}{5}=5$ or $5\frac{2}{5}.$ Ans.

Mensuration.

An area in the form of an equilateral triangle is paved at 9d. per sq. ft., and fenced at 5s. per ft.; show that the cost of fencing is to the cost of paving as 80 $\sqrt{3}$ is to three times the number of feet in a side.

Let x = no. of feet in side.

Then $3x$ = perimeter; and 5s. $\times\ 3x=15x$ = cost of fencing.

$\frac{x^2\sqrt{3}}{4}$ = area in sq. ft.; and $\frac{3}{4}$s. $\times\ \frac{x^2\sqrt{3}}{4}=\frac{3x^2\sqrt{3}}{16}$ cost of pav.

∴ Cost of fencing : cost of paving :: $15x:\frac{3x^2\sqrt{3}}{10}$

or $240x:3x^2\sqrt{3}$

or $80:x\sqrt{3}$

and ∴ $80\sqrt{3}:3x$

Q. E. D.

Arithmetic.

FEMALES.

1. Find the amount of £250 lent on October 27th, 1883, and repaid March 21st, 1884, at 5 per cent.

No. of days from Oct. 27th to March 21st
$= 4 + 30 + 31 + 31 + 29 + 21 = 146.$

$\therefore$ Interest $= \frac{£250 \times 146 \times 5}{365 \times 100} = £5$

and $\therefore$ the amount $= \underline{£255}$. Ans.

2. Find the cost price of a thing which if sold at 7 per cent. profit would realise 5s. more than if it were sold at 17 per cent. loss.

5s. $= \frac{107 - 83}{100}$ of cost price

$= \frac{24}{100}$ " "

$\therefore$ Cost price $= \frac{5s. \times 100}{24} = \underline{£1\ 0s.\ 10d.}$ Ans.

3. Divide £70 among 3 persons, so that their shares shall be to each other as 1, 2, and 3.

Total shares $= 1 + 2 + 3 = 6.$

	£	s.	d.
$\therefore$ 1st gets $\frac{1}{6}$ of £70, or	11	13	4. Ans.
2nd " $\frac{2}{6}$ " or	23	6	8. Ans.
3rd " $\frac{3}{6}$ " or	35	0	0. Ans.

4. In what time will £1240 amount to £1336 12s. 4d. at 4½ per cent. simple interest?

Interest $= £1336\ 12s.\ 4d. - £1240 = £96\ 12s.\ 4d.$

£	s.		£	s.	d.
$\therefore$ 4	5	:	96	12	4
20			20		
85			1932		
12			12		
1020d.		:	23188d.		
£1240		:	£100		

:: 1 yr. : Time.

$\frac{1 \text{ yr.} \times 23188 \times 100}{1020 \times 1240} = \frac{19}{8} = \underline{1\frac{3}{8}}$ yr. Ans.

Grammar.

MALES AND FEMALES.

1. It is well known to the learned that the ancient laws of Attica rendered the exportation of figs criminal; that being supposed a species of fruit so excellent in Attica that the Athenians deemed it too delicious for the palate of any foreigners; and in this ridiculous prohibition they were so much in earnest that informers were thence called 'sycophants' among them.

HUME.

Analyse each of the sentences in the above which begins with the word 'that.'

ANALYSIS.

Sentence.	Kind.	Subject.	Predicate.	Completion.	Extension.	Connective.
(1) That the ancient laws of Attica rendered the exportation of figs criminal; that being supposed a species of fruit so excellent	Subord. noun.	the ancient laws of Attica	rendered	the exportation of figs that being considered a species of fruit so excellent (*dir. obj.*) criminal (*indir. obj.* or *complement*)		that
(2) that the Athenians deemed it too delicious for the palate of any foreigners	Subord. adv.	the Athenians	deemed	it (*dir. obj.*) too delicious for the palate of any foreigners (*indir. obj.* or *complement*)		that
(3) that informers were thence called 'sycophants' among them.	Subord. adv.	informers	were called	sycophants (*indir. obj.* or *complement*)	among them (*place*)	that

2. Parse each word in the following:—

'That being supposed a species of fruit so excellent.'

PARSING.

That—demonstr. adj. pron., referring to 'fruit,' neut., sing., nom. absolute along with 'being.'
being—irreg. intrans. verb, *am, was, been*, incomplete part., forming with 'that' nom. absolute.
supposed—reg. trans. verb, complete part, predic. of 'that.'
a—adj. or indef. art., referring to 'species.'
species—abstr. noun, neut., sing., nom. after 'being supposed,' meaning the same as 'that.'
of—prep., relating 'species' to 'fruit.'
fruit—com. noun, neut., sing., obj., gov. by 'of.'
so—adv. of degree, mod. 'excellent.'
excellent—predic. adj., qual. 'fruit.'

3. Write out a list of words compounded or derived from the Latin verbs, 'amo,' 'duco,' 'fero,' 'audio.'

From 'amo' come; amorous, amiable, amatory.
" 'duco' " ductile, induce, re-, pro-, se-, conduce, reduction.
" 'fero' " ferry, infer, circumference, reference, defer.
" 'audio' " audit, audience, audible, auditor.

Geography.

Answer two Questions.

(*Answer Questions 1 and 2, and No. 3, if you have time.*)

1. How should you try to give to town children, who have never seen the sea, a clear idea of the nature of the tides? (Illustrate by diagram, and give examples of high or rapid tides)

INTRODUCTION.—Tell the children that though they may never have seen the sea, yet there is a rise and fall of its waters every 12 hours or so, enabling ships to go up rivers, and float down again, which, without 'tides,' would be impossible. (*Direct attention to the proportions of the land and water on the Map of the World, and give a few remarks on gravitation.*)

HOW TIDES ARE CAUSED.—They are produced by the attraction of the sun and moon, but principally by the influence of the moon. The moon attracts all things on earth; pulls them towards it; and water being fluid, changes its shape as it is pulled, and rises up towards the moon in a large heap. As the earth is spinning round all the time, the water is carried on and will not rise quite in the same shape that it would if it were at rest, but gets spread out into a broad flat wave. This tidal-wave goes travelling along over the surface of the sea following the moon, and always two or three hours behind it; and as it comes to the various places along the coast, it forms the high tide there. The moon rises a similar heap of water on the opposite side of the world, at the same time, so that there are always two tidal-waves going round at once, each half a day apart. The sun also attracts the water, though, from being so far off, much less than the moon does. When the two come in line, and pull together—that is at new and full moon—the tides are highest, and called *spring* tides; when they are at right angles to one another—that is at the moon's quarters—the tides are lowest, and called *neap* tides.

EXAMPLES.—The foregoing is the general principle of the tides, but it is very much interfered with by the form of the coast, the depth of the sea, the friction of the water on itself and on the shore, the action of the wind, the ocean currents, and many other things. The original height of the tidal-wave—the heap raised by the moon—is from 3 to 4 feet, which is the rise of the tide in the Pacific; but where there is a bay or inlet, with high steep walls, the water will force its way in, and rise much higher. In the Bristol Channel the tides are forced up as high as 30, and even 50 feet; and in the Bay of Fundy, to 70, 80, and even 100. On the coast of Jutland, in the German Ocean, owing to the tide-wave from the north meeting that from the south round Great Britain, there is little or no variation, but perpetual high water.

2. Draw a full map of the United States, and describe, as fully as you can, referring to your map, the water-partings and river-basins of that country.

(Insert the lines of latitude and longitude.)

The Alleghanies or Appalachian Chain extend from the Gulf of St. Lawrence to the State of Alabama, and form the water-parting between the rivers which flow into the Atlantic, and the two great basins of the Mississippi and the St. Lawrence.

The Rocky Mountains consist of two, and in some places of three, parallel chains; the two principal ranges being:—1. The Pacific Range, extending from Alaska to the peninsula of California, and forms the water-parting between the Pacific on the west and the Youcon and Rio Colorado on the east. 2. The Rocky Mountain Chain forms a wavy line from the mouth of the Mackenzie in the Arctic Ocean to near Lake Nicaragua in Central America, and separates the basins of the Columbia and the Rio Colorado on the west from those of the Missouri, Arkansas, and the Rio del Norte on the east.

All the rivers of this part of America belong to three great oceanic basins—viz., those inclining to the Atlantic, to the Gulf of Mexico, and to the Pacific. Besides these we have a continental basin, similar to those of the continents of the Old World—viz., the Great Basin in Utah and Nevada, which contains the Great Salt Lake, and many others which are salt, and have no outlet.

The great basin of the Mississippi is bounded on the east by the Alleghanies, and on the west by the Rocky Mountains.

3. Describe in order the different countries of South America, and say what you know about their history.

COUNTRIES OF SOUTH AMERICA.

1. *U. S. of Colombia*, formerly New Granada, in the N. W. It has been subject to several revolutionary changes and civil wars. *Ecuador* was founded in 1831 when the Republic of Colombia was divided into three sections. The Republic of *Venezuela* was established at the same time as Ecuador. *Guiana* is divided into three parts—British, Dutch, and French. British Guiana came into our possession in 1814. The whole originally belonged to the Dutch. *Brazil*, discovered in 1500, was colonised by the Portuguese. It became independent in 1822, when the government was vested in a hereditary emperor, a senate, and a chamber of representatives. *La Plata* or *Argentine Republic*, settled by Spain, 1553, has been virtually independent since 1806, but the authority of Spain was not openly set aside until 1810. *Paraguay* has been subject to many changes since Spain colonised it in 1535. During a war with Brazil in 1870, a full half of the male population was slain. *Uruguay*, formerly a province of Brazil, declared its independence in 1825, and became a free state in 1828, though it is virtually under the protection of Brazil. *Patagonia* is inhabited by a nomadic race of great stature. *Chili* (Spanish *Chilé*) was invaded by the Spaniards after the conquest of Peru. The colonists threw off the Spanish yoke in 1818, when the country became an independent republic. *Bolivia*, formerly a part of Peru, became independent in 1825, when it took the name of Bolivia from its champion Bolivar. *Peru* was first visited by the Spaniards in 1530. After its conquest by Pizarro, it continued subject to Spain till 1821, when it became independent.

SECOND PAPER.

Two hours and a half allowed.

Arithmetic.

MALES.

1. If a woman, by selling 5 herrings for 7d., gains 12 per cent., what per cent. would she gain by selling them 6 for 9d.?

5 cost 7d. ∴ 1 cost $\frac{7}{5}$d.
6 sell for 9d. ∴ 1 sells for $\frac{3}{2}$d.
∴ $\frac{7}{5}:\frac{3}{2}::112$: Hundredths of price.
$\frac{112\times3\times5}{2\times7}=120$ hundredths.
∴ the gain per cent. is 20. Ans.

2. A man invested money in the Three per Cents. at 101⅜, and on their falling to 100⅛ he sold out, and thereby lost £24. How much stock did he hold, and how much did he pay for it? (Omit brokerage.)

Loss on $101\frac{3}{8}=(101\frac{3}{8}-100\frac{1}{8})=£\frac{3}{4}$
(*a*) ∴ $£\frac{3}{4}:£24::101\frac{3}{8}$: Cost of stock.
$101\frac{3}{8}\times24\div\frac{3}{4}=\frac{811\times24\times4}{8\times3}=£3244$. Ans.
(*b*) $101\frac{3}{8}:100::3244$: Stock
$\frac{3244\times100\times8}{811}=£3200$ of stock. Ans.

3. If a banker, by deducting bankers' discount instead of true discount from a bill due eight months hence at 4½ per cent. per annum gains 9s., what is the amount of the bill?

Interest on £100 for 8 mos. at 4½ p. c. = £3.
∴ £3 or 60s. : 9s. :: £100 : True discount.
$\frac{£100\times9}{60}=£15$, true discount on the sum.
Now true discount on £103 for 8 mos., etc. = £3
∴ £3 : £15 :: £103 : Sum required.
$\frac{£103\times15}{3}=£515$. Ans.

Note.—The difference between the true and the usual discount is the interest on the true discount.

4. A and B, whose capitals are as 3 : 4, joined in business, and at the end of 4 months they withdrew ⅔ and ¾ respectively of their capitals; how should a gain of £624 be divided amongst them at the end of 12 months?

$(3\times4)+(\frac{2}{3}\times8)=26{\cdot}4$ per month for A.
$(4\times4)+(\frac{3}{4}\times8)=36{\cdot}$ „ „ B.
$62{\cdot}4$ „ for A and B.
∴ $\frac{26{\cdot}4}{62{\cdot}4}$ of £624 = £264, A's share. Ans.
624 − 264 = £360, B's „ Ans.

History.

MALES AND FEMALES.

1. What was the real extent of English success in Ireland under Henry II.? Give names and position of the Irish provinces at that period.

Though Prince John was established by Henry II. as Lord of Ireland after the nominal submission of the Irish kings, nothing but the feuds and weakness of the Irish tribes enabled the English adventurers to hold the districts of Drogheda, Dublin, Wexford, Waterford, and Cork, which formed what was known as the 'English Pale.' Had the Irish driven the invaders into the sea, or the English succeeded in the complete conquest of Ireland, much of its after history might have been avoided. Unhappily Ireland, while powerless to effect its deliverance, was strong enough to hold its assailants at bay. The country was broken into two halves, whose conflict has never ceased. The country was at that time divided into five principal kingdoms—Meath in the middle, Ulster in the north, Leinster in the south-east, Munster in the south-west, and Connaught in the west.

2. What improvements were introduced by Richard III. in reference to the statutes of Parliament, protection of commerce, and transmission of intelligence?

Richard III. met an appeal of the citizens of London by convoking Parliament, which had been all but discontinued under Edward IV., and by introducing sweeping measures of reform. In the one session of his brief reign he declared the practice of extorting money by 'benevolence' illegal; and the energy of the government was seen by a series of enactments striving to protect the growing interests of English commerce. The king's interest in literature showed itself in the provision that no statutes should act as a hindrance 'to any artificer, or merchant stranger of what nation or country he be for bringing unto this realm, or selling by retail or otherwise, of any manner of books written or imprinted.'

3. Account for the greater content of the English people at the present time compared with one hundred years ago.

The greater contentment of the English people may be accounted for from the following facts:—food, clothing, and luxuries are cheaper, taxation is very much lighter, education is now general; newspapers and books of every kind are more easily obtained; conveyance of passengers and letters brought nearly to perfection, Parliament (with some truth) represents the people; houses and sanitary arrangements improved, the criminal and poor-laws immensely advanced. The only questions that prevent full contentment seem to be those relating to land, liquor, labour, and government. Mr. Gladstone's proposed Franchise Bill promises to remove some of the wrongs of British voters.

Teaching.

Say how you would explain to scholars the difference between trades and professions.

THE DIFFERENCE BETWEEN TRADES AND PROFESSIONS.

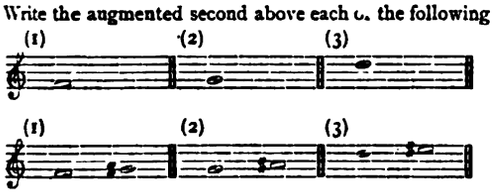
In defining the difference between a trade and a profession, it may be stated that the former is a handicraft occupation, and the latter an occupation depending chiefly on study and learning. The professions are acquired by long and laborious application at schools and universities, under professors specially eminent for their knowledge of certain branches of learning; while a trade may be acquired in a workshop or some technical school under practical masters who have gained their skill by experience in a special line of business. In the case of a trade a certificate of competency is very valuable and sometimes necessary; but to follow out a profession a diploma of a high order is absolutely required. The different kinds of trades are almost innumerable, and fall under the general term *skilled labour*. But professions are comparatively few on account of the time, labour, and money needed for mastering them; they are almost all comprised under these heads, the *medical*, *legal*, and *clerical professions*, which are sometimes called briefly the *learned professions*.

Music.

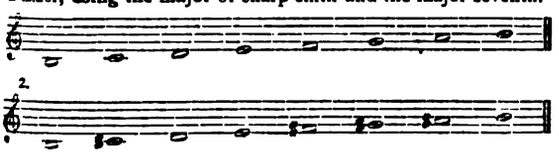
A quarter of an hour allowed for this paper.

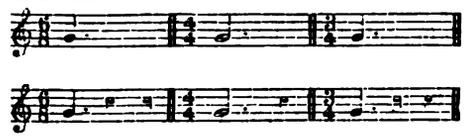
(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write the augmented second above each of the following:—



2. Write before the notes the sharps essential to the scale of B minor, using the major or sharp sixth and the major seventh.



3. Complete each of the following bars by adding the necessary rest or rests.

TONIC SOL-FA NOTATION.

1. What is the interval (*a*) between *fah* and *se*; (*b*) between *doh*' and *re*; (*c*) between *doh*' and *fe*?

1. (*a*) Augmented 2nd; (*b*) Augmented 2nd; (*c*) Diminished 5th.

2. In the minor mode (*a*) what is the essential sixth, and (*b*) what is the essential seventh?

2. (*a*) *Fah*; (*b*) *se*.

3. Re-write the following, doubling the value of every note and rest:—

|m . :s .,f |m .r : ‖

3. |m : |s :- .f |m :r | : ‖

Article 106 (b)

Merit Grant in Infant Schools.

BY MRS. MORTIMER,

Lecturer on Kinder-garten at the Home and Colonial Training College, London.

LESSON—THE PIGEON.

CLASS—CHILDREN UNDER SIX.

Apparatus:—Picture and stuffed specimen of common pigeon.

I. *Description.*—The stuffed specimen should be shown to the children, and they should be asked to name it.

Have any of you seen a pigeon alive? There is a little boy who says he has some pigeons at home. I expect he will be able to tell us a great deal about them.

What would you say about the size of the pigeon? It is not very large. Can you tell me the names of some birds that are smaller than the pigeon? Yes, the swallow, the sparrow, the robin, etc. Now, tell me some that are larger than the pigeon? The hen, the stork, the swan, etc.

Now, tell me the name of the different parts of the pigeon as I point to them. The head, the beak, the eyes, the neck, the wings, the body, the tail, the legs, the toes, the claws.

A picture of several birds should be shown, and then the teacher should call attention to the curved, or arched beak of the pigeon. For what does the pigeon use its beak? What is another name for the beak? What would you say of the wings? They are rather long and very strong.

The teacher pointing to another kind of pigeon should say, Both these birds are pigeons. Can you tell me any difference in them? Yes, the tail of that one stands up. Do you know anything that it looks like? It is something like a fan. (If the teacher were here to show the children a fan made of feathers, they would see the resemblance.) Yes, and because this pigeon's tail is like a fan, we call these pigeons *Fan-tail* pigeons. Now, tell me how many toes it has? Three in front, and one behind. What has it on the end of its toes? Claws. What can you say about them? They are curved.

Now, look at the neck of this bird. Is it like this pigeon's? No, it has a large lump on it. Yes, this is also a pigeon, and because the bottom part of the neck is large, we call these birds *Pouter* pigeons.

II. *Habits.*—There was one little boy who told me that he kept pigeons at home. I wonder if he will tell us where he keeps them? In a house in the garden; my big brother made it. That was very good of him. Do you ever see pigeon-houses in any other place? Sometimes they are put on the roofs of houses, and sometimes they are built against the side of a house. Of what are these houses made? Of wood. What are they like? Yes, like a large doll's-house, with a great many little round holes. For what are these holes made? For the pigeons to go into their house whenever they want to. Why do they not have one large hole? Because there are a number of small houses in the one large one, and the pigeon likes to have his own house and door. What do the pigeons do in these houses? They make their nests. Of what do they make them? When they have made them what do they do? Lay their eggs in them. Do you know how many eggs the pigeon lays? Yes, two pretty little white ones. See, here is one. Is it anything like the hen's egg? Yes, only it is very much smaller.

What does the pigeon do after she has laid the eggs? She sits on them to keep them warm, and after a time, when you go to look at the nest, instead of seeing eggs, what do you think you see? Yes, two very little pigeons, with hardly any feathers on. What do the old birds do for these young ones? They get food for them, and keep them very warm until all their feathers come, and they are quite strong. Then they teach them to fly.

What does the pigeon eat? Worms, and different kinds of seeds, oats, wheat, barley. Before the old pigeons give the young ones these seeds, they make them very soft. Do you know why that is? Yes, they are not strong enough to eat the hard seeds. It is just what your mother did when you were very little. She used to make the bread soft for you to eat, but now you can eat it without your mother boiling it.

There are a great many different kinds of pigeons. I have already told you about two. Which were they? The fan-tail pigeon. Why do you give it that name? The pouter pigeon. Why is it called the pouter pigeon? Then there is a very funny pigeon that keeps on turning over when it is flying in the air? I daresay if you saw it you would think it was going to fall down. This pigeon is called the *Tumbler*.

There is another kind of pigeon that I must tell you about, for it is very useful indeed. It is used to carry letters from one place to another a long way off.

Shall I tell you how they do this? The letter is written on very thin paper, and fastened under the bird's wing so as not to hurt its wing. The pigeon then flies into the air, and, after flying round, it begins to fly straight to the right place. Do you not think this is very clever? This kind of pigeon is called the *Carrier* pigeon.

There are several other kinds of pigeons, but these I must tell you about another day.

III. *Summary.*—This should consist of very simple sentences, and should be repeated by the children after the teacher, or a few very simple words should be printed on the blackboard.

The pigeon has a strong beak. It has strong wings. It has short legs. It lives on seeds and worms. There are many kinds of pigeons.

LESSON—FLOWERS.

CLASS—CHILDREN OVER SIX.

Apparatus: Specimens and pictures of flowers.

I. Now, children, we are going to talk about flowers. Why do you like them? Because they are pretty. Yes, and for some other reason? Because of their sweet smell. Now let us see how many names of flowers you can tell me. As each flower is mentioned the children should be asked to spell the name, and the teacher should write it on the blackboard. Of course, the teacher must not expect the children to spell every name, but by carefully separating the syllables, the majority of names will be spelt. Rose, wall-flower, daisy, primrose, crocus, violet, pink, geranium, fuschia, lily, stock, poppy, pansy, sweet-pea, marigold, buttercup, fox-glove, balsam, hollyhock, cowslips, nasturtium, sunflower, mignonette, tulip, daffodil, sweet william, London pride, dahlia, convolvulus, polyanthus, honeysuckle, chrysanthemum. Now read all these from the board as I point to them.

II. What time of the year do we see most flowers? In the summer-time. When do we see very few? In the winter. Yes, the flowers will not grow in the garden then. Do you know where they are then grown? Indoors. Yes, and sometimes houses are built on purpose for flowers, and fires are kept alight all the cold weather; if you were to go into such houses you would see a great many beautiful flowers. What do we call that part of the year when the flowers begin to come again in the garden? The spring. Now I want you to tell me the names of the flowers we see in the spring. See, we will put the figure 1 against the names of the spring flowers.

We walk into the garden and see some little snowdrops. What colour are they? White. And what is the colour of the crocus? Yellow. Yes, but sometimes it is blue, white, and striped. And the daffodils? etc.

What do we call the part of the year that follows spring? The summer. What kind of weather do we then have? And what does this very warm weather do? It makes the flowers grow. Yes, it makes all kinds of flowers grow. The garden is then full of flowers of all kinds of shapes and colours.

The children should now be asked to name the summer flowers, and the teacher should mark the figure 2 against them. It is more than likely that others will be mentioned. Which of all these flowers do you like the best? The rose. Why? Because it is so very beautiful, and smells so sweet and nice. Are all roses alike? Oh, no; there are a great many different kinds. Tell me some of the different kinds. Red, white, yellow, pink, and a very pretty one, with a kind of moss growing all round it. What is it called? The moss rose. Now look at these tulips. (Picture to be shown, if no specimens are obtainable), and tell me the different colours. A few other flowers might be picked out and treated in a similar manner, and the variety of shapes called attention to.

Now, when the summer has gone what kind of weather do we have? It begins to get cold, especially in the evenings, and the evenings seem to begin sooner. Yes, that is right; the evenings do begin sooner, and the weather is colder. What do we call this part of the year? Winter. No, it is not winter yet; we call this part of the year autumn. When does the autumn come? After the summer and before the winter. What kind of weather do we have? What flowers do we have in the autumn? Yes, many of the summer flowers will be seen. Do you know what will kill them? Yes, the cold, frosty nights. Then we have the asters, dahlias and chrysanthemums. The last one is a very long word for you, but I hope you will try to remember it.

After the autumn what do we have? The winter. And what kind of weather do we then have? Very cold weather. Can you tell me the names of any winter flowers? Yes, you see the chrysanthemums during the early winter-time.

III. As a recapitulatory exercise the children might then repeat the names of the flowers growing in each season. When this has been carefully done the children will have become familiar with the names of the ordinary flowers, and will be able to associate the flowers with their respective seasons. The teacher will feel after giving a lesson of this description, that she has made the children observe, and take an interest in the various objects that nature so bountifully supplies, and also that she is leading them to look out for the different varieties as each succeeding season approaches.

The children might now receive lessons on special flowers, according to the season of the year. In giving a lesson on a special flower the teacher should be careful to select one that is really in season, as she will then be able to procure a number of good specimens, *e.g.*, in the spring the crocus might be enlarged upon. Its size, the flower, its beauty, locality, growth from the bulb.

Again, the crocus, the snowdrop, and the daffodil might be taken together, and their description, etc., obtained by comparing one with the other.

In summer the rose, with its varieties in scent and colour, would make a suitable lesson.

Again, the geranium and fuschia might be taken together—the difference of stem, soft and hard; difference of leaf, round and pointed; and of flower, etc., obtained by comparison.

In autumn the beautiful and many-coloured chrysanthemums could be used for such a lesson, while in winter very interesting lessons could be given on the evergreens—the holly, the mistletoe, etc.

Again, a very useful and interesting lesson could be given by dividing the flowers into the groups, 'wild' and 'garden,' and the children taught where to look for the pretty wild flowers. Town children might have pointed out to them that some of their garden flowers are found growing wild in the country.

Another lesson would be formed by dividing the flowers into groups—beautiful flowers with scent, and beautiful flowers without scent. It might be pointed out to the children that most of the spring and autumn flowers have little or no scent.

LESSON—THE SILKWORM.

CLASS—CHILDREN OVER SIX.

Apparatus:—A silkworm, a chrysalis, a cocoon, a large drawing of silkworm.

I. *Description.*—Have you ever seen anything like this silkworm? Yes; a caterpillar, a worm. It is something like a worm, but much more like a caterpillar. Who has seen a caterpillar? Where have you seen one? Well, the silkworm is very much like one. What would you say about its shape? It is long and round. Do you know anything that is very much the same shape? Yes, a piece of pencil. What has this worm on its body? A number of legs. Let us count how many legs it has. All of you say. The silkworm has sixteen legs. How many legs have you? How many more legs than you has the silkworm? It also has a great many eyes. Seven on each side of the head. Now tell me then how many eyes it has.

II. *Habits and Food.*—The children should be asked if they know anything about silkworms. Some children like to keep them. Do you like to keep them? Why do you like to keep them? Because it is so nice to watch them. The silkworm changes several times. First of all it is to be seen flying about, and then we call it a moth. Do you know what a moth is? Where have you seen moths? Tell me an insect very much like a moth? Well, this moth has a short thick body covered with hairs. Tell me the name of another insect covered with hairs? The bee. The wings are white with darkish marks across them. They like to find a particular kind of tree, called the mulberry-tree. On the leaves of this tree the moth lays a number of tiny grey eggs. Do you know why she lays them on the leaves of the mulberry-tree? Well, listen, and I will tell you. The moth does not eat these leaves, but she knows that the tiny eggs will, in a few days, turn into little worms. These worms are very fond of the mulberry leaf, and they begin to eat very quickly, and eat all day long. What do you think this does? Yes, it makes the little worms grow very fast, and they keep on eating until they get quite big. They are then full grown and leave off eating, and begin to make something that is of great use to us. Do you know what this is? Yes, they begin to spin the silk. If you keep silkworms you will notice they wind this silk round and round their bodies, so that, when they have finished spinning, they are inside the silk. What does the silk look like when the silkworm has finished spinning? A little yellow ball. Of what shape? Something like an egg. What name do you give to this shape? We say it is of an oval shape. What colour is the silk? Where is the silkworm? Now you must learn the name of this oval piece of silk. It is called a '*cocoon.*' If you were to open the cocoon you would not find the caterpillar, for it has changed into a strange-looking thing. We say it has changed into a chrysalis. Is not that a long word? but if you look at it on the blackboard I do not think you will forget it. See, it is made up of three syllables, chrys a-lis.

The cocoon or silk ball is really the home of the chrysalis. Well, after a short time the chrysalis also changes, and you will see a moth come out of the cocoon. To get out, it has to make a hole right through the silk, and then the silk is not of much use. What did I tell you the moth does? It flies to the mulberry-tree, and lays its eggs on the leaves. Yes; it does not fly about very much, Now, can you tell me the different changes the silkworm passes through? Yes; first it is an egg, then a silkworm, and then a chrysalis. And what after? A moth. That is quite right. How many different changes? Four.

III. *Uses.*—You remember that I told you that the moth made a hole through the cocoon to get out. Well, this spoils the silk, so that when people want the silk good they put the cocoons into hot water, and that kills the chrysalis. The silk is then wound off the cocoon, and some day I will tell you how it is made into silk for dresses, neckties, and other things.

IV. *Summary.*—This should be written on the blackboard during the progress of the lesson, and should consist of simple words and sentences. The children should then write these sentences on their slates—

The silkworm is a kind of cat-er-pil-lar. It has sixteen legs and fourteen eyes. It eats the leaves of the mulberry-tree.

The silkworm spins a ball of yellow silk. We call this the cocoon.

The silkworm changes four times. An egg, a cat-er-pil-lar, a chrys-a-lis, and a moth.

Silk is used for making dresses and ties.

LESSON—SPOON, KNIFE, AND FORK.

CLASS—THE BABIES.

Apparatus:—Spoon, knife, and fork (a plated and steel fork).

I. The spoon, knife, and fork should be placed before the children, and after the children have named each they should be exercised in pointing to them when named.

II. *Description.*—Where have you seen these things before? At home. When do you see them? At breakfast-time, at dinner-time, and at tea-time. Tell me one name for these different times? Meal-times. Now look at the spoon. What can you tell me about it? It is white and bright. What do you call the part I am touching? The handle. And this part? The bowl. And this? The edge. What shape is the handle? Flat, and wider than the middle part. What can you say about the middle part? It is long and round. But this one? It is long and flat on each side. How many sides? Four.

What can you say about the bowl? Can you make your hand something like the bowl of the spoon? Yes, you have to bend it to make a hollow place. What is the use of this? It is used for holding tea, coffee, sugar, etc. Would you be able to take up tea in your spoon if the bowl were flat like the handle? What is the use of the handle? For what do we use spoons? To stir our tea, coffee, etc.; and to taste with. Sometimes we want spoonfuls of things, so then we use the spoon for a measure. Tell me some things your mother measures with the spoon. Tea, sugar, spice, and medicine.

When do we use spoons like this? (Teacher to hold up a small spoon.) At breakfast and tea-time. What do we call them? Tea-spoons. Have you seen any other kind of spoons? Yes, we have spoons at dinner-time. What can you tell me about those? They are much larger. Do you know what we call them? Table-spoons. Who uses the table-spoon? Our mother. For what does she use it? To serve us with potatoes, cabbage, etc. Would tea-spoons do for this? Why not? They would not be large enough to hold potatoes. The children should then repeat 'A spoon has a handle. A spoon has a bowl. We take hold of the handle when we use a spoon. We use spoons to eat our bread and milk with, to stir our tea, and eat our pudding.'

Now I will have a little boy to pick up the knife for me. Of which part of the knife does he take hold? The handle. Is this handle like the handle of the spoon? Do you know how they are different? The handle of the spoon is like the other part of the spoon; but the handle of the knife is quite different to the other part. What colour is the handle of the knife? Do you know of what it is made? Of bone. Who can touch another part of the knife? What part did Harry touch? The blade. Yes, and you must mind and touch it very carefully. Can you tell me why? Because it is very sharp. But what then? It might cut our fingers. So you see it is better for little children not to touch knives. Who uses them? Our mothers and fathers and our big brothers and sisters. For what do they use them? To cut bread, meat, and a great many other things. When they use knives how do they hold them? They take hold of the handles. With which hand? The right hand. If you look at a knife you will see that the edges are not alike. What can you

say about this one? It is very thin. Which edge do we call this? The front or sharp edge. And what can you say about this one? It is the back of the knife. And what else? It is not sharp. Why do we not have both edges sharp? Because we should cut our fingers when cutting the bread, etc. The children should then repeat, 'A knife has a blade and a handle. The blade of the knife has a sharp edge. It is used for cutting our food.'

Now who can tell me what else I have on the table? A fork. Come and pick up the fork for me. Which fork is most like the knife? This one. How is it like the knife? It has a handle like the knife? Yes, this has a bone handle. What is the handle of this fork like? It is like the handle of the spoon. Well, we will talk about the one like the knife. We call it a steel fork, because like the blade of the knife, it is made of steel. Has it a blade like the knife? No, it has not a blade. What do you see instead of a blade? Three pieces of steel. How do they feel? Very sharp at the ends. What will they do if you put them close up to your hand? They will prick it. We call these the '*prongs*.' How many prongs has this fork? Three. For what do we use the fork? To hold our meat when we want to cut it; and to put our food into our mouths. Why do we not use our knives for this? Because we might cut ourselves. Would not the spoon do? Yes, but not to hold things with when we want to cut them. Of what use are the prongs? They stick into the meat and hold it still. Ought little children to play with forks? No, they would hurt themselves if the prongs were to stick into them.

Now look at this fork. Which part is like the spoon? The handle. And how else is it like the spoon? It is all in one piece, and of the same metal. Most people now use forks like this one. How many prongs has it? Four. How many has this steel one? Three. Which one has the more? How many more?

The children should then repeat, 'The fork has a handle. It has three sharp-pointed prongs. We use a fork to keep our food still when we want to cut it with the knife. We put the food into our mouths with a fork.'

(*To be continued.*)

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The Discipline of the Mind.

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CHAPTER I.—*continued.*

More subtle is the question whether the 'unconscious' operations of mind are in every case rendered possible by previous acts of consciousness, whether aptitudes and immediate intuitions are processes of painful volition and arduous reflection, which have lost through repetition their emotional accompaniments, and so have seemed to have fallen out from the psychical into the physical order. Without attempting to decide this question, we may say, that when we seek to fathom the depths of our mental being we find ourselves in the presence of a vague spiritual atom, or rather molecule, which we find it hard to describe as either conscious or unconscious. Not wholly unconscious, for it is dimly represented; nor plainly conscious, for it is only the phenomenon at a much later stage that we feel of right deserves that appellation. This elementary molecule has both a passive and an active aspect, at once perceiving and striving, and forms the germinal vesicle from which (duly nourished) is hereafter expanded the rich organism with its myriad ramifications and blendings of thoughts, emotions, and volitions.

My readers will perhaps recognise my meaning more plainly if I translate this psychical elementary molecule into *Sensation;* and I have no objection to do so, if they will also take my meaning that the sensation is not simply a passive state of affection, but an active state of persisting or striving not to be. On no other terms can I consent to allow of the substitution. The matter is far too vital a one to be rendered uncertain by verbal associations. For the implication is no other than this, that the essence of Will is an ultimate fact of our mental constitution, no less original than feeling or cognition.

We will take sensation, then, as the undifferentiated matter of mind. Sensations arise either through change in the environment external to the organism as a whole, or to portions of it, as in those vaguer sensations which we locate with difficulty, or which arise in consequence of altered states of the blood circulation. Or they take the form of a consciousness concomitant with centrally-initiated movement, and thus reveal in germ that active phase of mind, which, in its most developed form, we are wont to regard as the supreme mental phenomenon.

The simplest phase of this psychical activity is familiarly known as the act of Attention—a phenomenon so uniformly present, during the waking state at least, that it is not seldom made co-extensive with consciousness itself. And, indeed, there is even some warrant for this, for Attention shades so finely into Inattention that it is difficult to mark the outer zone where simple *awareness* expresses the fact, and yet where subsequent reflection shows the mind must have been on the alert. The case of the somnambulist is sometimes cited as decisive of the reality of the distinction. The somnambulist carefully avoids obstacles, even performing feats of dexterity beyond the power of the same individual in the waking state, but apparently going through his various operations without being cognizant of the outward causes of his sensations, the receptivity being perfect, but perception *nil*. And it is at least a plausible suggestion that in such a state certain regions of the brain are entirely dormant, just those regions, in fact, which are aroused into activity when we exert a volition in that incipient form which we are so prone to consider as the essence of Cognition, the reaction of the mind whereby we trace our sensations to a producing object.

This act of the mind whereby we leave the primitive ground of sensibility, hold our sensations, as it were, at arm's length from us, and present them to ourselves as *objects*, is termed Perception; and the lowest animal, no less than the highest man, has this power, although doubtless the perceived object means something very different to the animal than it does to the man. It means something very different, because to man this intuited object means a Not Self, an item of apprehension which could not be possible to a being which had not risen to a higher stage of conscious existence than bare perception.

Although the theoretical psychologist is accustomed to separate sensation from perception, and to insist upon the priority of the former, it is very doubtful whether pure sensation is a fact of conscious experience. We learn in physics that action and reaction are equal and opposite, and in psychophysics, or psychology, it is not improbable that action and passion are an inseparable pair. It is true that

the localization of sensation is often vague in the extreme, but it is difficult to imagine an unlocalized sensation. Now this localizing of sensation is a characteristic feature of perception, a localization, which, it should be observed, is due not to some ready-formed extra-mental attribute, but to the mind's own energy. Were we only passive our sensations would only have intensive, but not extensive quantity; we might discriminate difference of degree of feeling, acuteness and massiveness of sensation, but we should not spread out these sensations into a continuum, not assign them a relation of co-adjacence as well as of co-intension.

The life of perception is more or less immediate or concrete. Although the actual basis of subjective affection may be small, the experience is essentially real, and although the additions from ideal memory may be considerable, we are warranted in regarding the perceiving attitude as the attitude of reality *par excellence*. But when the stimulus is removed we drop from the public sphere of reality, and are left in the realm of private ideality. A man's perceptions are not his alone; in possessing them he participates in a common life; but a man's memories and thoughts are his and his alone. The vivid percept is first degraded to the faint image, and the image finally loses all form and colour in the idea.

Another expression for this sequence of events is that conscious life consists in a passage from the concrete to the abstract. The primary experience exhibits the maximum of concreteness. The world of the young child is a world of actual vivid feeling, absolutely articulated, a robe of perception without a seam. As some of the causes of its impression are uniformly withdrawn it finds a difference of colouring in its experience, and learns to distinguish between the objects actually present and the paler surviving relics of its memory. By transposition of stimuli, moreover, the fixity of primary association is infringed, and the youthful mind learns to partition its experience, and to form a more precise representation of the world of things.

The multiplication of experiences does something more than this, however; it makes the retention of images more and more difficult, and the necessity of keeping pace with a world in such constant flux and progress reduces the major part of these images into signs. The process here alluded to is the mental attribute termed Abstraction, and the ability to perform such an act indicates an immense advance in intellectual power.

But now, did the control of conscious experience end there it would never have been possible to define man as *animal rationale;* for rationality implies operation not on particular, but on *general* signs, and to effect that an instrument must be constructed which shall facilitate representative knowledge, which shall not only enable the mind to *perceive* a lion from a certain odour or colour, but allow the mind in its solitude to *think* lion, as in the unspoken judgment 'lions are dangerous beasts,' without any concrete reminder, either through the medium of the sense-organ or the internal organ of imagination.

For thought, for reasoning, we require a mental algebra, and the quantities of this algebra are termed *Conceptions.* The concept is related to the percept as the *a*'s and *b*'s of common algebra to the pebbles and other discrete objects of daily experience. By its aid the single rational intuition may do duty for numberless sensible intuitions, and we can carry on a train of thought that without such a symbolic language would have been impossible.

From the system of sense to the system of thought we creep thus gradually. To us of the present day the chasm seems inconceivably vast between the prevailing life of perception of the brute and the prevailing life of conception of the civilised man, but the gulf may not really be so great as it seems. The missing link —the origin of language—will doubtless be detected by the penetrating eye of future science.

The civilised child, as standing nearer to the primitive age of the race, leads a life still largely perceptional. To try and *force* the youthful mind beyond its constitutional capacity to the higher stages is both vain and injurious. A premature absorption in reflection and abstraction not only atrophies the body, but also engenders a barren schematism, in which the mind spends precious time in the fruitless working of a new instrument, without the application to material, for which the instrument is alone desirable. But as time goes on, the operations on signs rather than on the things signified must make up a large part of the doings of consciousness, and *judging* and *reasoning* be the daily portion.

Very early indeed the habit is formed of striving to enlarge the area of experience by purely rational processes. Uneducated and educated alike are prone to make universal assertions on the strength of a very slender amount of evidence, the practical utility of an 'all' giving, doubtless, the cue to this usually erroneous extension of the known. If we are to believe the school-books, the counter process is even more common, of pushing the vast stock of supposed general truths, whether derived from tradition or through the operation just described, into all their consequences. But I take leave to doubt whether this 'deductive' operation, as it is technically termed, is really as general as our logical teachers would give us to understand. The actual state of the case seems to be far rather that alleged by J. S. Mill, when he maintains that the primitive and common mode of inference is from particulars to particulars on the ground of superficial resemblances. We *induce* or make general assertions on the strength of a few instances fast enough; but we rarely deduce, or reason downwards from assumed general principles, unless our vocation lie, as with the judge or the mathematical physicist, especially in this direction.

The performance of the intellectual operations of which mention has been made is never *unmotived*, although the motive may not always be self-evident or even conscious. Will, as I hinted above, is, in my opinion, not synonymous with volition, the former being a genus, of which the latter is a species. A volition I define as an act of the mind, determined by a motive distinctly presented to consciousness, and a large number of our activities, although plainly mental or subjective, do not possess these consciously realized antecedents. While, then, in the case of many centrally-initiated activities it is hard to say why and how they arise, when once they are set on foot, and generate associations and intellectual combinations, of various orders, they are either continued in virtue of something else than their own momentum, or retarded by another cause than their own inertia. All acts of the mind are with rare exceptions accompanied by a conscious ingredient termed pleasure or pain.

They either cause delight or occasion a sense of displeasure. The exceptional cases are when the physical or psychical stimulus is, in relation to the excitability of the system, of so limited an amount as to arouse the mind from its torpor and nothing more, or when by long action of the stimulus, the mind has grown accustomed to the new condition, an increment or decrement of stimulus being required to change its tone.

When the pleasure or the pain is detached from its intellectual surroundings, and made a distinct object by consciousness, volition occurs, and we are said to work for a specific end. What ends we should work for, and what motives to the will we should suppress by a counter effort, in view of a still greater good, is the problem of the discipline of the will—a subject of supreme importance, which will subsequently require a paper to itself. I will here only make the psychological observation that the work of volition must not be judged by the complexity of the impelling motives. It is not the circumstance of deliberation and resulting resolution that is the characteristic mark of a voluntary act, but the initiating of movement itself. Whether the motives be one or a hundred, will is always there when the mind is strained to effect a certain purpose.

The conflict of motives just alluded to, however, introduces us to the circumstance hitherto passed by in silence, that the mind is often the theatre of intense struggle; that, indeed, as the tendency to regard volition as emerging from conflict shows, it is an internal sea, where perfect calm is rather the exception than the rule, and violent storms alternate with gentle breezes. The definition of man as *animal rationale* is indeed partial in the extreme. The emotions are not the least permanent or least important part of our mental constitution, and the culture of the emotions presents even a more difficult problem than that of the intellect. A wrong heart is at least as mischievous as a wrong head, and there is not a little danger that in our anxiety to avoid the intellectual aberrations of our ancestors, and to make the mind a better mirror of the rational order than heretofore, we may leave to chance the training of the instinctive feelings, and the social sympathies, and so let the tares of lawless impulse choke the wheat of knowledge we have so sedulously sown. If the motive of intellectual veracity obtain by strenuous habit complete sway over the wandering trains of thought and a too eager imagination, the mind will be still ill-prepared for encountering the real stress of actual life, unless the motive of moral veracity, and a strict regard to the legitimate feelings and rights of others, constrain individual action to a perfect harmony with social needs and endeavours.

The contents and purport of this introduction may be thus briefly summarised. The education of youth, to be successful, that is, to fit the child to play a worthy part in after-life, must be in obedience to the laws of mind. A complete understanding of these laws would require a thorough knowledge of the antecedents of the particular mind. Such antecedents are and always will be for the most part unknown. The most we can hope for is to understand the general workings of the mind, assuming a uniformity of operation under approximately uniform conditions. The teacher will, however, as far as circumstances permit, carefully note deviations from the normal type, and vary his practical rules in accordance with the peculiarities of the case. The business of the psychologist is to trace out the statics and dynamics of a typical human mind, to resolve compound mental operations into their proximate and ultimate elements, and to explain the mechanism by which mental results are obtained. The practical teacher will accept these theoretical inductions and deductions from the hands of psychologists, and will be guided by them in practice, possibly repaying the debt by collecting fresh facts for the elucidation of the theorist, the favourable opportunity possessed by him of witnessing the development of minds from a comparatively early age having as yet been hardly sufficiently utilised.

The maxim which has been found so fruitful in other departments will bear excellent fruit here likewise: 'Follow nature,' understanding by nature in the present instance those co-existences and sequences which have been established by the psycho-physical adhesive growths of centuries, which we may modify, but cannot undo.

(To be continued.)

Chemistry of the Non-Metallics.

BY EDWARD B. AVELING, D.SC. LONDON.

[This series of articles, whilst dealing with the subjects required by the University of London for the Matriculation Examination and with those required at the Elementary Stage of the Inorganic Chemistry (Branch X.) Science and Art Department, is intended as a practical guide to the philosophical and systematic study of the non-metallics.]

CHAPTER III.

Hydrogen. ὑδωρ (hudor) = water, γενναω (gennao) = I form. It is one of the elements of water.

SYMBOL. WEIGHT-NUMBER. PREPARATIONS. THE METRIC SYSTEM. LAW OF VOLUMES. ACIDS AND ALKALIES.

A. SYMBOL.—H.

B. WEIGHT-NUMBER.—1.

C. PREPARATIONS.—First preparation. From zinc and sulphuric acid.

(1) *Laboratory Method.*—Take a double-necked bottle, commonly called a Woulff's bottle, and fit its necks with two corks. A wide-mouthed flask may be used in place of the doubled-necked bottle (Fig. 2). In the former case bore both corks; in the latter bore two holes

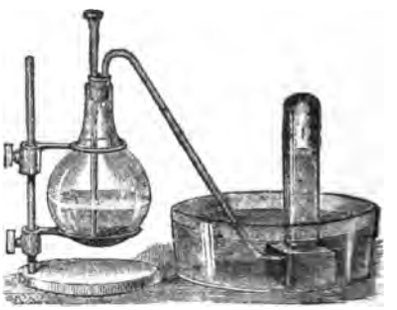


Fig. 2.

in the one large cork with which you fit the mouth of the flask. As one hole is to be traversed by a thistle-funnel, and the other by a piece of glass tubing, use cork-borers a little less in diameter than the tube of the thistle-funnel and the glass tubing respectively. Wet the borer, and push and turn it at the same time; beginning at the small end of the cork. Pass through one cork the thistle-funnel, after wetting or greasing it. Here also push and

twist simultaneously. Let the funnel tube go through the cork to such a length, that it will nearly reach the bottom of the bottle. Before introducing the glass tubing into the other cork, the tubing must be bent as in the figure, or bent twice; once at right angles at a point that will afterwards be near the cork, once at an obtuse angle at a point some 6 or 8 inches from the cork. To cut the piece of tubing off from a length of tubing, a notch is made with a file in the glass, by drawing the file, not too vigorously, across it, until it has eaten into the glass. The cut may be extended in a circle round the tubing, and then the latter being laid on the thumbs and over-grasped by the fingers, the cut lying between the two forefingers, pressure with the thumbs, and

Fig. 3.

gentle drawing with the hands to right and left, cause the tube to break with a clean fracture. If the edges are not quite smooth, heat them in the flame of a Bunsen burner (Fig. 3), directed upon the glass by aid of a blow-pipe (Fig. 4).

Fig. 4.

To bend the glass tubing. Hold it in the upper part of the flame of a batwing gas-burner, a burner with a long narrow aperture, turning it round and round. When the glass softens, bend it steadily but slowly at the required angle, after removing it from the flame.

Introduce one end of the piece of glass-tubing that has been bent twice, once at a right angle and once at an obtuse angle, into the other cork, or pass it through the second hole in the single large cork. Let it only just pass into the bottle. To the other end of this delivery-tube attach a piece of india-rubber tubing, and to the remote end of the latter a piece of glass tubing bent upwards at its free end.

Partially fill a pneumatic trough with water, and place in the water a bee-hive or hollow cylinder of earthenware, with a hole in the top, and with part of one side cut away (Fig. 5.) Fill with water several gas-jars, and

Fig. 5.

invert them in the trough, taking care that no air enters, no water escapes. Let the end of the delivery-tube pass into the bee-hive through the cut-away side-wall.

Place in the bottle some granulated zinc. Pour through the funnel enough water to cover the zinc and the lower open mouth of the thistle-funnel. Then add sulphuric acid (hydrogen sulphate) through the same channel, taking care that the proportion of water to acid is about 12 to 1. The zinc is dissolved by the acid and takes the place of the hydrogen, forming a salt, zinc sulphate, that is left in solution within the bottle. The hydrogen gas thus displaced escapes through the delivery-tube, and after expelling the air from the bottle, rises through the water in the trough and escapes at the opening in the top of the bee-hive. When you judge that all the air has been expelled, and that hydrogen is now bubbling off, pass a gas-jar on to the bee-hive, letting no water escape, and allow the gas to displace the water in the gas-jar. When the jar is full of gas and empty of water, pass it from the bee-hive on to a plate-glass plate that serves to close the lower open mouth, and remove the jar filled with hydrogen from the water. It should be kept mouth downwards. Catch three or four jars' full in this way, and then catch one or two by displacement of air, holding the jars mouth downwards, and closing each jar when you think it is full of hydrogen, with the glass plate.

The zinc used in this experiment must not be pure zinc. Upon pure zinc the action of sulphuric acid is *nil*, unless a drop or two of a solution of some lead or copper salt is placed in the vessel. Then, as the zinc is rendered impure, action takes place, and hydrogen is evolved.

In this preparation, zinc and hydrogen sulphate become hydrogen and zinc sulphate.

(2) *Symbols.*—$Zn + H^2SO^4 = H^2 + ZnSO^4$. Zn stands for the metal zinc : H^2SO^4 for the hydrogen sulphate or sulphuric acid, which consists of two atoms of hydrogen, one of sulphur, four of oxygen. H^2 represents the hydrogen that passes off : $ZnSO^4$ the zinc sulphate left in the bottle, and made up of one atom of zinc, one of sulphur, four of oxygen.

(3) *Weights and Volumes.*—Zn has weight-number 65 approximately (see table in last number, p. 12). H = 1, S = 32, O = 16. Hence—

$$\begin{array}{rcl} Zn + H^2SO^4 & = & H^2 + ZnSO^4, \\ 65 + \frac{(2+32+64)}{98} & & 2 + \frac{(65+32+64)}{161} \end{array}$$

i.e., 65 parts by weight of zinc, treated with ninety-eight parts by weight of hydrogen sulphate, yield 2 parts by weight of hydrogen and 161 parts by weight of zinc sulphate.

Volume has only reference to bodies in the gaseous condition, and in this experiment hydrogen is the only gas concerned. H^2 represents two atoms or two volumes.

We are already using the words weight, volume, atom. Let us once for all make clear the meaning of these words.

The system of weights and measures used by all scientific workers is the metric system. Its unit of length is the metre, a ten-millionth part of a quadrant of the earth's meridian. In English measures the metre is 39·37 inches = 3·281 feet or a little more than a yard. The metre is divided into tenths, hundredths, thousandths. The metre is grouped up into multiples of ten, of one hundred, of a thousand metres. The sub-multiples are named from the Latin words decem = ten, centum = one hundred, mille = a thousand, respectively decimetre ($\frac{1}{10}$ of a metre), centimetre ($\frac{1}{100}$ of a metre), millimetre ($\frac{1}{1000}$ of a metre). The multiples are named from the Greek words δεκα (deka) = ten, ἑκατον (hecaton) = a hundred, χιλιοι (chilioi) = a thousand, respectively decametre (10 metres), hectometre (100 metres), kilometre (1000 metres).

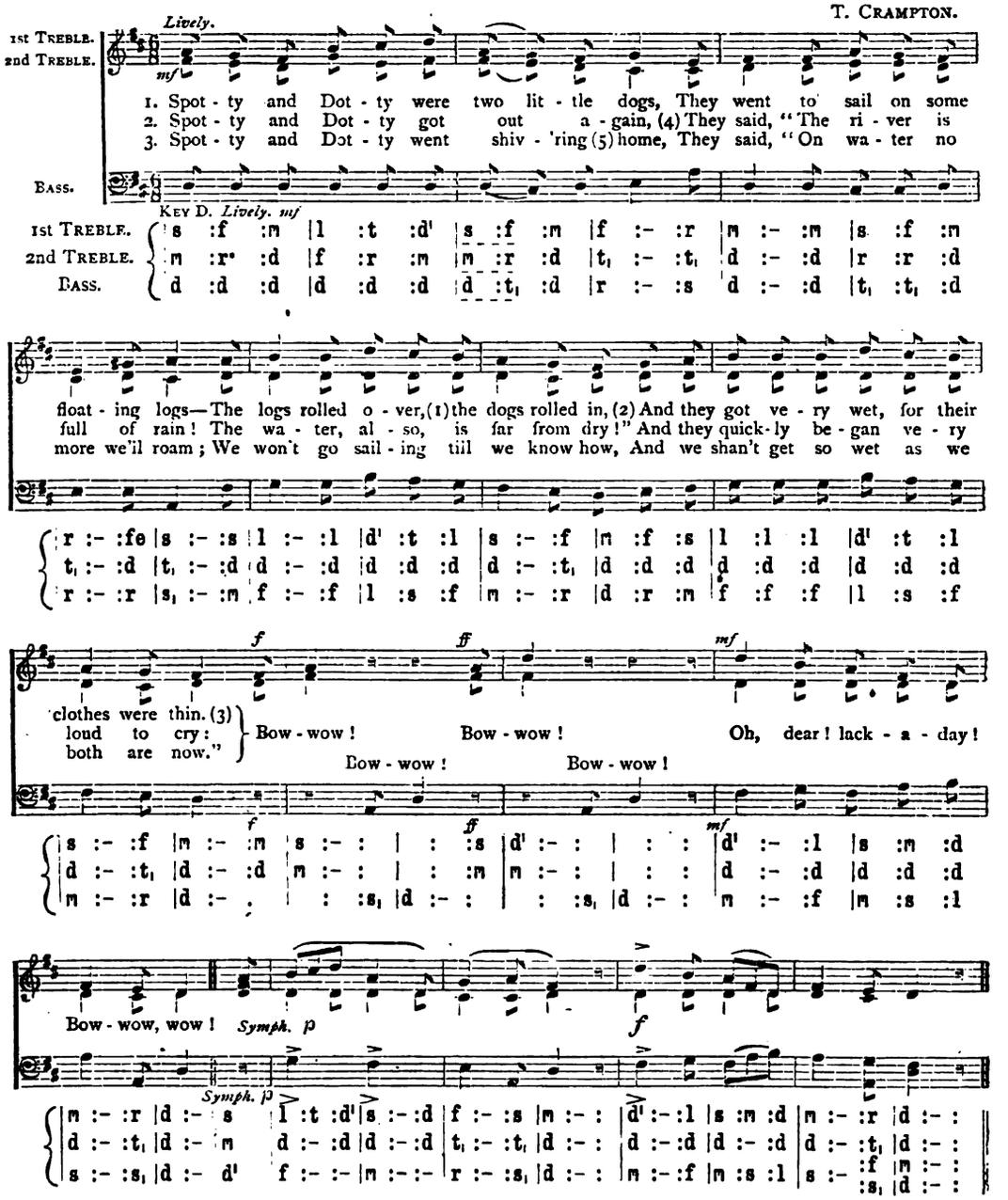
The unit of volume is the *litre.* This is a cubic decimetre, *i.e.*, 1000 cubic centimetres ($10^3 = 1000$). Its English equivalent is 1·765 imperial pints, or 61·03 cubic inches. This, on the same principle as that used in dealing with the metre, may be divided into decilitres, centilitres, millilitres, and grouped up into deca-hecto-kilolitres.

The unit of mass, or quantity of matter, and of weight, is the *gram.* This is the mass or weight of a cubic centimetre of distilled water at a temperature of 4°C, and under a pressure equivalent to that of a column of mercury 760 millimetres in height. Its English equivalent is 15·432 grains. This is divided into decigrams, centigrams, milligrams, and is grouped up into decagrams, hectograms, kilograms.

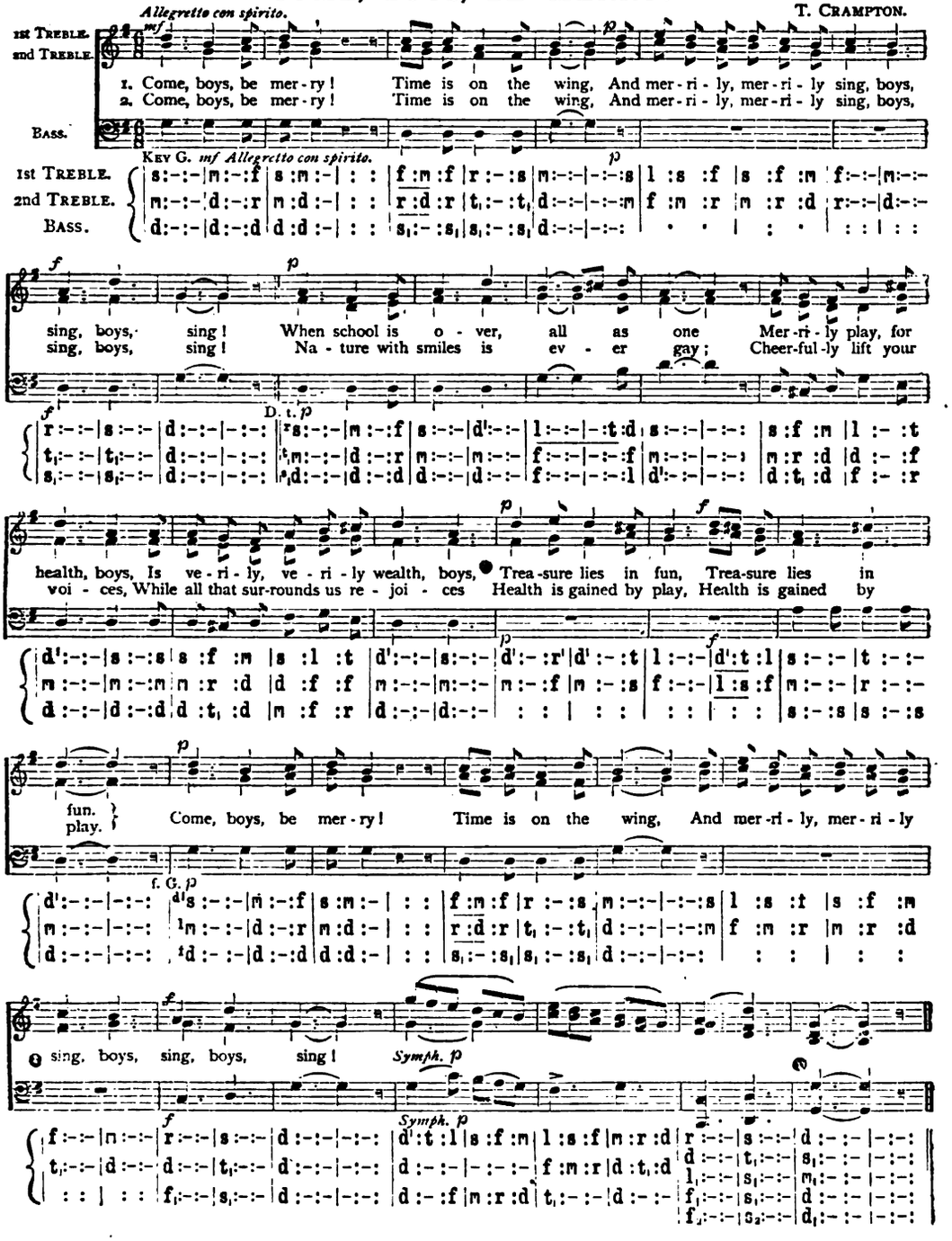
(To be continued.)

SPOTTY AND DOTTY.

T. CRAMPTON.


1st TREBLE.
2nd TREBLE.
Lively.
mf
1. Spot - ty and Dot - ty were two lit - tle dogs, They went to sail on some
2. Spot - ty and Dot - ty got out a - gain, (4) They said, "The ri - ver is
3. Spot - ty and Dot - ty went shiv - 'ring (5) home, They said, "On wa - ter no
BASS.
KEY D. Lively. mf
1st TREBLE. | s :f :m | l :t :d' | s :f :m | f :- :r | m :- :m | s :f :m
2nd TREBLE. | m :r :d | f :r :m | m :r :d | t, :- :t, | d :- :d | r :r :d
BASS. | d :d :d | d :d :d | d :t, :d | r :- :s | d :- :d | t, :t, :d
float - ing logs—The logs rolled o - ver, (1) the dogs rolled in, (2) And they got ve - ry wet, for their
full of rain! The wa - ter, al - so, is far from dry!" And they quick - ly be - gan ve - ry
more we'll roam; We won't go sail - ing till we know how, And we shan't get so wet as we
| r :- :fe | s :- :s | l :- :l | d' :t :l | s :- :f | m :f :s | l :l :l | d' :t :l
| t, :- :d | t, :- :d | d :- :d | d :d :d | d :- :t, | d :d :d | d :d :d | d :d :d
| r :- :r | s, :- :m | f :- :f | l :s :f | m :- :r | d :r :m | f :f :f | l :s :f
f
ff
mf
clothes were thin. (3)
loud to cry:
both are now."
Bow - wow!
Bow - wow!
Oh, dear! lack - a - day!
Bow - wow!
Bow - wow!
f
ff
mf
| s :- :f | m :- :m | s :- : | : :s | d' :- : | : : | d' :- :l | s :m :d
| d :- :t, | d :- :d | m :- : | : :m | m :- : | : : | d :- :d | d :d :d
| m :- :r | d :- : | : :s, | d :- : | : :s, | d :- : | m :- :f | m :s :l
Bow - wow, wow!
Symph. p
f
Symph. p
| m :- :r | d :- s | l :t :d' | s :- :d | f :- :s | m :- : | d' :- :l | s :m :d | m :- :r | d :- :
| d :- :t, | d :- m | d :- :d | d :- :d | t, :- :t, | d :- : | d :- :d | d :- :d | d :- :t, | d :- :
| s :- :s, | d :- d' | f :- :- | m :- :- | r :- :s, | d :- : | m :- :f | m :s :l | s :- :f :s, | m :- : d :- :
(1) Move both arms round. (2) Point downwards. (3) Point to clothing. (4) Raise both arms upwards.
(5) Shrug shoulders as in shivering.

COME, BOYS, BE MERRY!

T. CRAMPTON.

Allegretto con spirito.
mf
1st Treble.
2nd Treble.
Bass.
1. Come, boys, be mer-ry! Time is on the wing, And mer-ri-ly, mer-ri-ly sing, boys,
2. Come, boys, be mer-ry! Time is on the wing, And mer-ri-ly, mer-ri-ly sing, boys,
Key G. mf Allegretto con spirito.
sing, boys, sing! When school is o-ver, all as one Mer-ri-ly play, for
sing, boys, sing! Na-ture with smiles is ev-er gay; Cheer-ful-ly lift your
D. t.
health, boys, Is ve-ri-ly, ve-ri-ly wealth, boys, Trea-sure lies in fun, Trea-sure lies in
voi-ces, While all that sur-rounds us re-joi-ces Health is gained by play, Health is gained by
fun.
play.
Come, boys, be mer-ry! Time is on the wing, And mer-ri-ly, mer-ri-ly
f. G.
sing, boys, sing, boys, sing!
Symph.

ANSWERS TO ARITHMETICAL QUESTIONS IN THE 'SCHOLAR' FOR APRIL, 1884.

STANDARD III.

A. 1. 2,247,716—4
2. 85,250—73.
3. £723 5s. 3⅜d.
B. 1. £97,434 7s. 9¾d.
2. £5231 5s. 9¼d.
3. 342,106—75.
C. 1. 41,944,240.
2. £32,592 8s. 2¾d.
3. £70,701 2s. 6¼d.
D. 1. 187,804—14.
2. 360 baskets.
3. £499 18s. 5¾d.
E. 1. 1152 lb.
2. 6 561,586 farthings.
3. £793 11s. 3¾d.
F. 1. 6,521—6287
2. £158,690 6s. 6¾d.
3. £3 13s. 10¼d.

Advanced Examination.

1. £11 8s. 7½d.
2. 40 nuts.
3. £289 2s. 0¾d.

STANDARD IV.

A. 1. 312⅜ inches.
2. £7 4s. 4½d—360.
3. 212 ton 11 cwt. 1 qr. 7 lb. 6 oz.
B. 1. £71,064 3s. 0¾d.
2. £236 5s. 8½d.
3. £31 9s. 1d.
C. 1. £147.
2. 8 d. 19 h. 37 m. 5 s.
3. £12,772 15s. 6¾d.
D. 1. 14,691,540 sec.
2. 101,730 halfpence.
3. 84 coats and ½ yd. 1 ft.
E. 1. £3 4s. 5½d.—93.
2. 96 boards.
3. 152,460 sq. ft.
F. 1. £5 4s. 10d.
2. 2304 pints.
3. 15 c. yd. 9 ft. 1457 in.

Advanced Examination.

1. 3⅜d.
2. Hand-made, £1 5s.
3. 373,248 bricks.

STANDARD V.

A. 1. £75 8s. 1½d.
2. £249 11s. 11½d.
3. £6 17s. 3⅝d.
B. 1. 4⅛.
2. £1 3s. 0½d.
3. £172,913 10s. 9d.
C. 1. £13 2s. 5½d.
2. £9555.
3. 1⅛.
D. 1. 3¾ miles.
2. £15 8s. 0¾d.
3. £82 9s. 2½d.
E. 1. £5103 2s. 6d.
2. 3⅝.
3. £17,560 10s. 11¼d.
F. 1. 101 tons.
2. 8 ton 18 cwt. 12 lb. —153.
3. £405.

Advanced Examination.

1. 1/20.
2. 27s. 6d. and 22s. 6d.
3. £367 8s. 4 1/80d.

STANDARD VI.

A. 1. 2 19/20.
2. £1 7/80.
3. £1 10s.
B. 1. 86·2365.
2. £73 13s. 9 9/25d.
3. £52 17s.
C. 1. £137 14s. 1 1/4d.
2. 4 inches thick.
3. £1027 4s.
D. 1. £75 5s. 3d.
2. 3½ per cent.
3. 4½ years.
E. 1. 17 11/36 8/35.
2. 24·354.
3. £5 18s. 4 2/5d.
F. 1. 645996+.
2. £660.
3. 74⅔ acres.

Advanced Examination.

1. 15s. 7½d. left.
2. 7/100 lb.
3. 73 days.

STANDARD VII.

A. 1. £443 13s. 2⅛d.
2. £7354.
3. 5/16 per cent.
B. 1. 1s. 7⅞d.
2. 5s. 11 7/32d.
3. £73 15s. 4 8/11d.
C. 1. 4 27/44 per cent.
2. £11 9s. 8 1/11d.
3. £68 8s. 6·912d.
D. 1. 11s. 8⅛d.
2. 97⅞.
3. 6s. each.
E. 1. £1 10s. 10 4/100d.
2. 25 ton 1 qr. 7 lb.
3. 9 51/176 per cent.
F. 1. £2365.
2. £140.
3. 21½ per cent. gain.

Advanced Examination.

1. 255 present.
2. £450.
3. 2 per cent. gain.

SOLUTIONS OF THE 'ADVANCED EXAMINATION' QUESTIONS IN 'THE SCHOLAR' FOR APRIL, 1884.

STANDARD III.

1.

£	s.	d.
14	17	6
21	12	6
0	17	9
0	17	9
0	17	9
£39	3	3

£	s.	d.
27	10	0
0	4	7½
£27	14	7½

£	s.	d.
39	3	3
27	14	7½
£11	8	7½ Ans.

2. 10 × 35 = 350, excess that girls get above an equal share with boys. Then 2150 − 350 = 1800, and 1800 ÷ (25 + 35 = 60) = 30, a boy's share, hence 30 + 10 = 40, a girl's share. Ans.

3.

	£	s.	d.
46,173 twopences =	384	15	6
91,845 farthings =	95	13	5¼
	£289	2	0¾ Ans.

STANDARD IV.

1. 5d. × 2240 × 2 = £93 6s. 8d. selling price of 2 ton.
£120 + £36 6s. 8d. = £156 6s. 8d. total selling price.
£156 6s. 8d. − £93 6s. 8d. = £63, selling price of 1 ton 16 cwt.
1 ton 16 cwt. = 4032 lb., and £63 ÷ 4032 = 3¾d. Ans.

2. 10 years or 120 months = 8 times 15 months.
,, ,, = 12 ,, 10 ,,
14s. 6d. × 8 = £5 16s. cost of 8 pair of hand-made.
11s. 9d. × 12 = £7 1s. ,, 12 ,, machine ,,
Hence *hand-made* are cheaper by £7 1s. − £5 16s. = £1 5s.

3. 972 × 27 × 1728 × 2 = 90,699,264 *half* c. inches, and 141½ = 243 half c. in.; and 90,699,264 ÷ 243 = 373 248 bricks. Ans.

STANDARD V.

1. 6¾ + 4⅘ + 3⅞ = 15 4/40, and 24⅝ − 8⅚ = 15⅝;
then 15⅝ − 15 4/40 = 7/440. Ans.

2. As the ewe is worth *twice* as much as the lambs, the ewe and the lambs *together* are worth *three times* as much as the lambs; then £7 10s. ÷ 3 = £2 10s. the worth of the two lambs. But one lamb is worth 5s. more than the other, hence £2 10s. − 5s. = £2 5s., *twice* the worth of the worse lamb, and £2 5s. ÷ 2 = £1 2s. 6d. worth of one lamb, and £1 2s. 6d. + 5s.
= £1 7s. 6d. worth of the other. Ans.

3. The five items of the bill are:—£39 7s. 9d. + £48 12s. 2d. + £113 12s. + £31 4s. 1cd. + £159 1s. 6d. = £391 18s. 3d.; on which 1s. 3d. in the £ (*i.e.* 1/20) = £24 9s. 10½d., leaving net £367 8s. 4 8/10d. Ans.

STANDARD VI.

1. As the first bill required ⅝ of the £60, then ⅝ of £60 = £37 10s. the first remnant. As ⅜ of *this* was paid, ¼ of £37 10s. = £9 7s. 6d. the second remnant. Similarly, ¼ of £9 7s. 6d. = £3 2s. 6d. the third remnant, and ¼ of £3 2s. 6d. = 15s. 7½d., the final remnant. Ans.

2. 6⅞ cwt. = 770 lbs., and the same fraction of 770 lbs. could be bought for £·0075 as it is of £7 10s. or £7·5. Multiplying both by 10,000 we have 75 and 75,000, the former being 7 5/10 00 = 1 1/000 of the latter; hence 1/1000 of 770 lbs. = 77 lbs. Ans.

3. $\frac{365 \text{ days} \times £1\not{0}\not{0} \times 1\not{8}\text{s.}}{5\ £9\not{0} \times 1\not{0}\not{0}\text{s.}}$ = 73 days. Ans.

STANDARD VII.

1. 276 × 10 = 2760 units of attendance in 10 times.
280 × 7 = 1960 ,, ,, 7 ,,
800 ,, ,, last 3 ,,
Excess of Friday a.m. over Friday p.m. = 15, and excess of Thurs. p.m. over Friday p.m. = 20; total excess of the two together = 35. Then 800 − 35 = 765, *three* times Friday p.m.'s attendance, and 765 ÷ 3 = 255. Ans.

2. £1 would amount to £1·124864; then £506·1888 ÷ £1·124864 = £450. Ans.

3. At the former price the globes that cost £100 would sell for £85, then at the latter price they would sell for 8/7 of £85 = £102, selling price of £100's worth of globes; hence 2 per cent. gain Ans

Query Column.

RULES.

1. Each correspondent is restricted to *one question*. We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.

2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.

3. ☞ When a pseudonym is adopted it should be written at the end of the query, and the real name and address on a separate piece of paper.

4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.

5. Replies will not be sent through the post.

6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—'*The Query Editor*,' *The Practical Teacher*, *Pilgrim Street, Ludgate Hill, London, E.C.*

Arithmetic.

1. BONA DEA.—If I buy 3 per cents. at 78⅝ and 3½ per cents. at 95 1/16, which is the better investment? If I had invested £6,962 19s. 3¾d. in each, and the former rose and the latter fell 1/16, how much should I lose or gain?

$$\text{First stock} : \text{Second stock} :: \frac{3}{78\frac{5}{8}} : \frac{3\frac{1}{2}}{95\frac{1}{16}},$$
$$:: \frac{24}{629} : \frac{28}{1523},$$
$$:: 8 \times 1523 : 28 \times 209,$$
$$:: 12{,}184 : 5{,}852\ ;$$

∴ 3 per cents. at 78⅝ is the better investment.

£ £ s. d. £
78⅝ : 6,962 19 3¾ :: 1/16 : Gain on First investment.
8
627
2 £ s. d.
1254)6,962 19 3¾
£5 11 0⅝ Gain.

£ £ s. d. £
95 1/16 : 6,962 19 3¾ :: 1/16 : Loss on Second investment.
16
1523
= £4 11s. 5½d. Loss.

∴ Gain = £5 11s. 0⅝d. − £4 11s. 5½d.
= 10s. 7⅛d.

2. BESTIA.—If the 3 per cents. be at 91, how much must a person invest in order that he may have a yearly income of £460, after paying 7d. in the pound for income tax? (*Barnard Smith.*)

s. d. £ £
19 5 : 460 :: 1 : Income with income-tax.
12
233

$$= \frac{460 \times 240}{233}\text{£} = \underline{\underline{\text{£}\tfrac{110400}{233}}}.$$

£ £ £
∴ 3 : 110400/233 :: 91 : Amount invested.

$$= \frac{\overset{1840}{\cancel{110400}} \times 91}{\underset{1}{\cancel{3}} \times 233}\text{£} = \underline{\underline{\text{£}\tfrac{334880}{233}}}$$
$$= \underline{\underline{\text{£}14{,}372\ 10\text{s.}\ 7\tfrac{14}{233}\text{d.}}}\ \text{Ans.}$$

Note.—Your writing is *very good*, and we cannot suggest any improvement.

3. H. F. C.—A farmer went to market and spent £100. He bought 100 animals, consisting of bullocks, sheep, and ducks. For each bullock he gave £5, for each sheep £1, and for each duck one shilling. How many of each did he buy?

Average price = £100 ÷ 100 = £1;
Difference between price of bullocks and average price
= £5 − £1 = £4;
Difference between price of ducks and average price
= £1 − 1s. = 19s.;

∴ No. of bullocks : No. of ducks :: 19s. : £4,
:: 19 : 80.

∴ No. of bullocks = 19
,, ducks = 80
,, sheep = 100 − (19 + 80)
= 100 − 99
= 1
} Ans.

4. JENNIE.—A owes B a debt payable in 7 3/10 months, but he pays ¼ in 4 months, ¼ in 6 months, and ¼ in 8 months; when ought the remainder to be paid? (*Barnard Smith.*)

(4 months × ¼) + (6 months × ¼) + (8 months × ¼)
+ [Time for remainder × {1 − (¼ + ¼ + ¼)}] = 7 3/10 months,
¼ months + ½ months + ⅔ months
$+ \left\{\text{Time for remainder} \times \left(1 - \frac{20+15+12}{60}\right)\right\} = 7\tfrac{3}{10}$ months,
$\frac{40+45+48}{30}$ months + {Time for remainder × (1 − 47/60)},
= 7 3/10 months,
1 23/30 months + (Time for remainder × 13/60) = 7 3/10 months,
Time for remainder × 13/60 = 7 3/10 months − 1 23/30 months,
$= \frac{211-133}{30}$ months,
$= \frac{78}{30}$ months
$= 2\frac{18}{30}$ months,
12

$$\therefore \text{Time for remainder} = \left(\frac{\cancel{78}}{\cancel{5}} \times \frac{\cancel{60}}{\cancel{78}}\right) \text{months}$$
= 12 months. Ans.

Note.—About 70 per cent.

5. M. R. S.—Two pieces of silver plate are melted down together; the first weighs 3 lbs. 4 oz. and contains 9 per cent. of alloy, and the second weighs 5 lbs. 5 oz. and contains 6 oz. of alloy; find the percentage of pure silver in the whole mass.

Weight of pure silver in first piece = 3 lbs. 4 oz. × 91/100
2
$= \frac{\overset{13}{\cancel{52}} \times 91}{\underset{25}{\cancel{100}}}$ oz.
5
= 36⅖ oz.;
,, ,, ,, second ,, = 5 lbs. 5 oz. − 6 oz.
= (65 − 6) oz.
= 59 oz.;
Weight of the whole mass = 3 lbs. 4 oz. + 5 lbs. 5 oz.
= (40 + 65) oz.
= 105 oz.;
,, ,, pure silver in the whole mass
= (36⅖ + 59) oz.
= 95⅖ oz.;

∴ Percentage of pure silver in the whole mass
159 4
$= \frac{95\frac{2}{5}}{105} \times 100 = \frac{\overset{159}{\cancel{477}} \times \overset{4}{\cancel{20}}}{\underset{21}{\cancel{105}} \times \underset{1}{\cancel{5}}}$
7
$= 90\frac{6}{7} = \underline{\underline{90\tfrac{6}{7}\%}}$. Ans.

6. TEACHER.—Two clocks point to 2 o'clock at the same instant on the afternoon of Christmas day; one loses 8 seconds,

and the other gains 9 seconds in 24 hours; when will one be half an hour before the other, and what time will each clock then show? (*Brook Smith.*)

sec. min. day
17 : 30 :: 1 : Time for difference of ½ hour.
$= \frac{30 \times 60}{17}$ days $= \frac{1800}{17}$ days $= 105\frac{15}{17}$ days
$= 105$ days 21 hrs. 10 min. $35\frac{5}{17}$ sec.

∴ Time = 10 min. $35\frac{5}{17}$ sec. past 11 a.m. on April 10th.

Time lost by first clock $= (105\frac{15}{17} \times 8)$ sec.
$= 847\frac{1}{17}$ sec.
$= 14$ min. $7\frac{1}{17}$ sec.;
,, gained ,, second ,, $= 30$ min. $- 14$ min. $7\frac{1}{17}$ sec.
$= 15$ min. $52\frac{16}{17}$ sec.;
∴ Time shown by first clock $= 56$ min. $28\frac{4}{17}$ sec. past 10 a.m.,
or 3 min. $31\frac{13}{17}$ sec. to 11 a.m.;
Time shown by second clock $= 26$ min. $28\frac{4}{17}$ sec. past 11 a.m.

7. OXONIAN.—A man invested a sum of money in $4\frac{1}{2}$ per cent. stock at $1\frac{1}{2}$ per cent. premium, and allowed the investment to accumulate at simple interest. The stock went down in value for 9 years at the average rate of $\frac{1}{2}$ per cent., and then improved in value for 5 years at the average rate of $\frac{1}{4}$ per cent., at the end of which time he was able to draw out £49,387 10s. What sum did he invest?

Increase for an investment of £101½
$= (£4\frac{1}{2} \times 14) + (£\frac{1}{4} \times 5) - (£\frac{1}{2} \times 9)$
$= £63 + £1\frac{1}{4} - £1\frac{1}{2} = £63\frac{1}{4}$;
Amount drawn out for an investment of £101½
$= £101\frac{1}{2} + £63\frac{1}{4} = £164\frac{3}{4}$:
£ £ £
∴ $164\frac{3}{4}$: 49,387½ :: 101½ : Sum invested.
8 4 2
1317 197550 203
150
$= £30,450$. Ans.

8. PUPIL TEACHER.—In a subscription list, one-half of the subscriptions are a guinea each, one-third 10s. 6d. each, and the 4s. subscriptions, which complete the list, amount to £10. Find the amount subscribed. (*Caxton* Arithmetical Test Cards.)

No. of subscriptions at 4s $= £10 \div 4s.$
$= 200s. \div 4s. = 50$;
,, ,, ,, ,, $= \{1 - (\frac{1}{2} + \frac{1}{3})\}$ of the whole number
$= \frac{1}{6}$ of the whole number;
∴ Total number of subscriptions $= 50 \times 6 = 300$;
∴ Amount subscribed $= (£1\ 1s. \times 150) + (10s.\ 6d. \times 100) + £10$
$= £157\ 10s. + £52\ 10s. + £10$
$= £220$. Ans.

9. W. E. MILTON.—A bill falls due in 6 months. The creditor agrees to accept immediate payment of one half, and to defer payment of the other half for one year. He finds by this arrangement, reckoning interest at 6 per cent. per annum, he gains 9s. What is the amount of the bill?

Suppose amount of bill were £100;
Amount at end of year $= £100 + (6\%$ on $£50) = £103$.
Interest on £100 for 6 months at $6\% = £3$;
£ £ £
∴ 103 : 100 :: 100 : Present worth of bill.
$= \frac{10000}{103}$ £;
Amount at end of year $= £\frac{10000}{103} \times \frac{106}{100}$
$= £\frac{106000}{103} = £102\frac{94}{103}$;
∴ Gain $= £103 - £102\frac{94}{103} = £\frac{9}{103}$;
£ s. £
∴ $\frac{9}{103}$: 9 :: 100 : Amount of bill.
$= (103 \times 5)$ £ $= £515$. Ans.

10. DANDRUM.—A church clock is set at 12 o'clock on Saturday night; at noon on Tuesday it is 3 minutes too fast. Supposing its rate regular, what will be the true time when the clock strikes four on Thursday afternoon? (*Barnard Smith.*)

Time from 12 o'clock on Saturday night to noon on Tuesday $= 2$ days 12 hrs.;
Time from 12 o'clock on Saturday night to four o'clock on Thursday afternoon $= 4$ days 16 hrs.;

dys. hrs. min. dys. hrs. min.
∴ 2 12 3 : 4 16 :: 3 : Time gained.
24 24
60 112
60 60
6720
1201
$= 5\frac{719}{1201}$ min.
∴ True time $= 5\frac{719}{1201}$ min. to 4.

11. J. L. E. N.—There are three candidates at an election, at which it is necessary that at least one more than half the entire number of electors should vote for the successful candidate. A fails to obtain an absolute majority, although he has twenty votes more than B; but C, whose votes are only three-tenths of B's, withdraws, and one-fourth of his supporters vote for A on the second ballot. A is then successful, without, however, a vote to spare. How many votes were given to each candidate on the first occasion? (*Cassell's Saturday Journal.*)

(1) A's voters + B's voters + C's voters = No. of electors.
That is B's voters + 20 + B's voters + $\frac{3}{10}$ of B's voters
= No. of electors,
$2\frac{3}{10}$ times B's voters = No. of electors − 20,
∴ B's voters = (No. of electors − 20) × $\frac{10}{23}$.

(2) A's voters + ¼ of C's voters = ½ No. of electors + 1,
B's voters + 20 + ¼ of $\frac{3}{10}$ of B's voters = ½ No. of electors + 1,
$1\frac{3}{40}$ times B's voters = ½ No. of electors − 19,
∴ B's voters = ($\frac{4}{43}$ No. of electors − 19) × $\frac{40}{43}$.

∴ ($\frac{4}{43}$ No. of electors − 19) × $\frac{40}{43}$ = (No. of electors − 20) × $\frac{10}{23}$,
$\frac{4\ (\frac{4}{43}\text{ No. of electors} - 19)}{43} = \frac{\text{No. of electors} - 20}{23}$,
92 ($\frac{4}{43}$ No. of electors − 19) = 43 (No. of electors − 20),
46 times No. of electors − 1,748 = 43 times No. of electors − 860,
46 times No. of electors − 43 times No. of electors = 1,748 − 860,
3 times No. of electors = 888,
∴ No. of electors = 296.

∴ B's voters = (No. of electors − 20) × $\frac{10}{23}$
= (296 − 20) × $\frac{10}{23}$ = 276 × $\frac{10}{23}$,
= 12 × 10 = 120;
A's voters on the first occasion = 120 + 20
= 140;
C's ,, ,, ,, ,, = $\frac{3}{10}$ of 120
= 36.

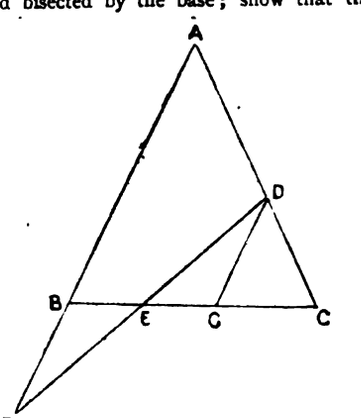
12. HAWTHORN.—In a tricycle race the rates of speed of A, B, and C, are as 7 : $6\frac{6}{7}$: $5\frac{3}{4}$ for the first half of the course. A slackens at completing this, and C increases his speed on doing so, B travelling at the same rate throughout. The rates of speed consequently for the second half of the course are as $5\frac{1}{2}$: $6\frac{6}{7}$: $6\frac{7}{8}$. In what order do they reach the goal?

A's time : B's time : C's time
$:: \frac{\frac{1}{2}\text{ course}}{7} + \frac{\frac{1}{2}\text{ course}}{5\frac{1}{2}} : \frac{\text{course}}{6\frac{6}{7}} : \frac{\frac{1}{2}\text{ course}}{5\frac{3}{4}} + \frac{\frac{1}{2}\text{ course}}{6\frac{7}{8}}$,
$:: \frac{1}{14} + \frac{1}{11} : \frac{7}{48} : \frac{2}{23} + \frac{4}{55}$,
$:: \frac{11+14}{154} : \frac{7}{48} : \frac{110+92}{1265}$,
$:: \frac{336}{1540} : \frac{245}{1540} : \frac{302}{1265}$,
:: 25 × 53 × 115 : 8 × 154 × 115 : 202 × 14 × 53,
:: 152,375 : 141,680 :: 149,884.
∴ B arrives first, C second, and A last.

Note.—Your writing is *good*, but it is too fine.

Geometry.

1. ADDLE-PATED.—A straight line is drawn, terminated by one of the sides of an isosceles triangle, and by the other side produced, and bisected by the base; show that the straight



lines, thus intercepted between the vertex of the isosceles triangle and this straight line, are together equal to the two equal sides of the triangle. (*Potts.*)

Let ABC be an isosceles triangle, and let the straight line DEF be drawn, bisected by the base in E, meeting AC in D, and AB produced in F.

Then the straight lines FA, AD shall be together equal to AB, AC, that is, BF shall be equal to CD.

Draw DG parallel to AB (I. 31), meeting BC in G.

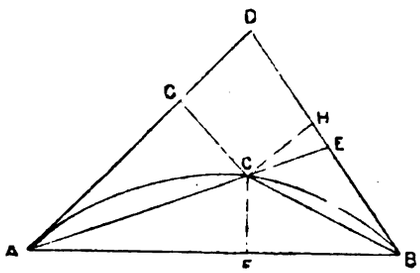
Proof.—In the triangles FBE, DGE,

$\angle FEB = \angle DEG$, (I. 15.)
$\angle FBE = \angle DGE$, (I. 29.)
And side FE = Side DE, (Hyp.)
$\therefore$ Side BF = Side DG. (I. 26.)

Again, in the triangle DGC,

$\angle DGC = \angle ABC$, (I. 29.)
And $\angle DCG = \angle ABC$, (I. 5.)
$\therefore \angle DGC = \angle DCG$, (Ax. 3).
Wherefore side DC = Side DG, (I. 6.)
But BF = DG;
$\therefore$ BF = DC. (Ax. 3.) Q. E. D.

2. CRICKETARIAN.—Given the base, the vertical angle, and the radius of the inscribed circle of a triangle, construct it. (*Todhunter.*)



Construction.—Upon the given base AB describe a segment of a circle, containing an angle equal to the sum of the vertical angle and half its supplement; (III. 33.)

At a distance from AB equal to the given radius draw a straight line parallel to AB, and meeting the arc in C;

Join AC, BC;

Make the angle CAD equal to the angle CAB, and the angle CBE equal to the angle CBA;

Produce BE to meet AD in D;

Then ADB shall be the triangle required.

Draw CF, CG, CH perpendicular to AB, AD, BD respectively.

Proof.—Because $\angle ACB$ = Vertical angle and half its supplement,

$\angle$s CAB, CBA = Half the supplement (I. 32.)
And their equals, $\angle$s DAC, DBC = Half the supplement;
But $\angle ACB = \angle$s CBE, BEC (I. 32.)
$= \angle$s CBE, EAD, ADE, (I. 32.)
That is, $\angle$s DBC, DAC, ADB;
$\therefore \angle$s DBC, DAC, ADB = Vertical angle and half its supplement,
And $\angle$s DBC, DAC = Half the supplement,
$\therefore \angle ADB$ = Vertical angle.

Again, in the triangles CAG, CAF,

$\angle CAG = \angle CAF$, (Con.)
$\angle CGA = \angle CFA$, (Ax. 9.)
And side CA is common to the two triangles,
$\therefore$ Side CG = Side CF; (I. 26.)
Similarly it can be proved that CH = CF;
$\therefore$ CF, CG, CH are equal.

Wherefore C is the centre of the inscribed circle (III. 9.), and ADB is the required triangle. Q. E. F.

Mensuration.

1. KNUDSEN.—How many paving stones, each of them a foot long and $\frac{4}{5}$ of a foot wide, will be required for paving a street 45 feet wide, surrounding a square, the side of which is 225 feet?

Area of street $= \{(225+45) \times 45 \times 4\}$ sq. ft.
$= (270 \times 180)$ sq. ft. $= 48{,}600$ sq. ft.;
Area of each stone $= 1$ ft. $\times \frac{4}{5}$ ft. $= \frac{4}{5}$ sq. ft.;
$\therefore$ No. of stones required $= 48{,}600 \div \frac{4}{5} = 12{,}150 \times 15$
$= 182{,}250$. Ans.

2. TREWERRY.—The area of a square cricket-field is 9 ac. 3 ro. 8·16 po. A running path of the uniform width of 3·9 yards is constructed close to the boundary of the field at a cost of 4d. per square yard, and the remainder of the field is laid down in turf at a cost of 5s. 6d. per hundred square yards. Find the total cost of preparing the field. (*Cambridge Senior*, December, 1874.)

9 ac. 3 ro. 8·16 po. $= 1{,}568{\cdot}16$ po.;
Side of field $= \sqrt{1{,}568{\cdot}16}$ po. $= 39{\cdot}6$ po.
$= 217{\cdot}8$ yds.;
Area of path $= \{(217{\cdot}8 - 3{\cdot}9) \times 3{\cdot}9 \times 4\}$ sq. yds.
$= (213{\cdot}9 \times 15{\cdot}6)$ sq. yds;
$= 3{,}336{\cdot}84$ sq. yds.;
Cost " " $= \frac{3336{\cdot}84}{3}$s. $= 1{,}112{\cdot}28$s.
$= £55\ 12s.\ 3\frac{3}{5}d.$;
Area of turfed part $= [\{217{\cdot}8 - (3{\cdot}9 \times 2)\}^2]$ sq. yds.
$= 210^2$ sq. yds. $= 44{,}100$ sq. yds.;
Cost " " $= 5s.\ 6d. \times 441 = £121\ 5s.\ 6d.$;
$\therefore$ Total cost of preparing the field
$= £55\ 12s.\ 3\frac{3}{5}d. + £121\ 5s.\ 6d.$
$= £176\ 17s.\ 9\frac{3}{5}d.$ Ans.

3. JACK AND JILL.—A closed vessel formed of metal, 1 inch thick, whose external dimensions are 8 ft. 3 in., 7 ft. 5 in., and 4 ft. 3 in., weighs 3 cwt. 1 qr. 8 lbs. What would be the weight of a solid mass of metal of the same dimensions? (*Brook Smith.*)

Solidity of vessel $= [\{8 \text{ ft. } 3 \text{ in.} \times 7 \text{ ft. } 5 \text{ in.}) + \{8 \text{ ft. } 3 \text{ in.} \times (4 \text{ ft. } 3 \text{ in.} - 2 \text{ in.})\} + \{(7 \text{ ft. } 5 \text{ in.} - 2 \text{ in.}) \times (4 \text{ ft. } 3 \text{ in.} - 2 \text{ in.})\}] \times 1 \text{ in.} \times 2.$
$= [\{(99 \times 89) + (99 \times 49) + (87 \times 43)\} \times 2]$ cub. in.
$= \{(8{,}811 + 4{,}851 + 4{,}263) \times 2\}$ cub. in.
$= (17{,}925 \times 2)$ cub. in. $= 35{,}850$ cub. in.;
Content of a solid mass of the same dimensions
$= 8$ ft. 3 in. $\times 7$ ft. 5 in. $\times 4$ ft. 3 in.
$= (99 \times 89 \times 51)$ cub. in. $= 449{,}361$ cub. in.

Cub. in.	Cub. in.	cwt.	qrs.	lbs.	
$\therefore$ 35850	: 449361	:: 3	1	8	: Weight of solid mass.

5975 | 62 | 4

898722 | 13
2696166 | 28
27860382 | 371

62

5975)27860382(4662
23900

39603
35850

37538
35850

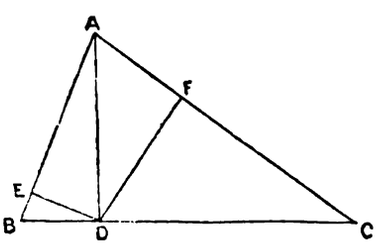
16882
11950

4932

$= 4{,}662\frac{4932}{5975}$ lbs. $= 166$ qrs. $14\frac{4932}{5975}$ lbs.
$= 2$ tons 1 cwt. 2 qrs. $14\frac{4932}{5975}$ lbs. Ans.

Note.—Your capital letters are the principal defects in your writing.

4. H. T.—ABC is a triangle, and AD is the perpendicular from A on BC. If AD = 13 feet, and the lengths of the perpendiculars from D on AB and AC be 5 feet and 10·4 feet respectively, find the sides and the area of the triangle. (*Todhunter.*)



$AE^2 = AD^2 - DE^2$
$= 13^2 - 5^2$
$= 169 - 25$
$= 144$
$\therefore AE = 12.$

$AF^2 = AD^2 - DF^2$
$= 13^2 - 10{\cdot}4^2$
$= 169 - 108{\cdot}16$
$= 60{\cdot}84$
$\therefore AF = 7{\cdot}8.$

The triangle ADB is right-angle, and DE is the perpendicular on the hypotenuse AB,

$\therefore AE \times EB = DE^2$
$12 \times EB = 5^2 = 25$
$\therefore EB = \frac{25}{12}.$

Similarly, $AF \times FC = DF^2$
$7{\cdot}8 \times FC = 10{\cdot}4^2 = 108{\cdot}16$
$\therefore FC = 108{\cdot}16 \div 7{\cdot}8 = \frac{1352}{117}.$

$BD^2 = DE^2 + EB^2$
$= 5^2 + (\frac{25}{12})^2$
$= 25 + \frac{625}{144}$
$= \frac{4225}{144}$
$\therefore BD = \frac{65}{12}.$

$DC^2 = DF^2 + FC^2$
$= (\frac{52}{5})^2 + (\frac{1352}{117})^2$
$= \frac{2704}{25} + \frac{1827904}{13689}$
$= \frac{70225600}{342225}$
$= \frac{2704}{9}$
$\therefore DC = \frac{52}{3}.$

$AB = AE + EC$
$= (12 + 2\frac{1}{117})$ ft.
$= 14\frac{1}{117}$ ft.

$AC = AF + FC$
$= (\frac{39}{5} + \frac{1352}{117})$ ft.
$= \frac{117 + 2c8}{15}$ ft.
$= \frac{3225}{15}$ ft.
$= \frac{645}{3}$ ft.
$= 21\frac{2}{3}$ ft.

$BC = BD + DB$
$= (\frac{65}{12} + \frac{52}{3})$ ft.
$= \frac{65 + 208}{12}$ ft.
$= \frac{273}{12}$ ft. $= \frac{91}{4}$ ft.
$= 22\frac{3}{4}$ ft.

Area of triangle $ABC = (BC \times AD) \div 2 = (\frac{91}{4} \times \frac{13}{2})$ sq. ft.
$= \frac{1183}{8}$ sq. ft. $= 147\frac{7}{8}$ sq. ft.

5. NELLIE.—Find the area of the surface of a cube, which contains 733,626,753,859 cubic inches.

Side of cube $= \sqrt[3]{733,626,753,859}$ cub. in.

733,626,753,859(9,019
729

$90^2 \times 300 = 2,430,000$	4,626,753
$90 \times 1 \times 30 = 2,700$	
$1^2 = 1$	
2,432,701	2,432,701
$901^2 \times 300 = 243,540,300$	2,194,052,859
$901 \times 9 \times 30 = 243,270$	
$9^2 = 81$	
243,783,651	2,194,052,859

Surface of cube $=$ Side$^2 \times 6 = (9,019$ in.$)^2 \times 6$
$= 81,342,361$ sq. in. $\times 6$
$= 488,054,166$ sq. in. Ans.

Algebra.

1. H. BULL.—Solve :—

$\sqrt{2x} + \sqrt{2x-3} = 3.$
$\sqrt{2x} + \sqrt{2x-3} = 3$
$\sqrt{2x-3} = 3 - \sqrt{2x}$
$2x - 3 = 9 - 6\sqrt{2x} + 2x$
$6\sqrt{2x} = 12$
$\sqrt{2x} = 2$
$2x = 4$
$\therefore x = 2.$

Note.—You will notice that the above solution is simpler than yours. You made an error in working it, or you would have obtained the same result.

2. H. DAWSON.—Solve :—

$\frac{x+a}{x-a} - \frac{x-a}{x+a} + \frac{x^2}{x^2-a^2} = 1.$
$\frac{x+a}{x-a} - \frac{x-a}{x+a} + \frac{x^2}{x^2-a^2} = 1$
$(x+a)(x+a) - (x-a)(x-a) + x^2 = x^2 - a^2$
$x^2 + 2ax + a^2 - (x^2 - 2ax + a^2) = -a^2$
$x^2 + 2ax + a^2 - x^2 + 2ax - a^2 = -a^2$
$4ax = -a^2$
$4x = -a$
$\therefore x = -\frac{a}{4}.$

3. WAT TYLER.—Find the value of

$$\frac{1}{(a-b)(a-c)(x-a)} + \frac{1}{(b-a)(b-c)(x-b)} + \frac{1}{(c-a)(c-b)(x-c)}. \quad (Todhunter.)$$

$$\frac{1}{(a-b)(a-c)(x-a)} + \frac{1}{(b-a)(b-c)(x-b)} + \frac{1}{(c-a)(c-b)(x-c)}$$
$$= \frac{1}{(a-b)(a-c)(x-a)} - \frac{1}{(a-b)(b-c)(x-b)} + \frac{1}{(a-c)(b-c)(x-c)}$$
$$= \frac{(b-c)(x-b)(x-c) - (a-c)(x-a)(x-c) + (a-b)(x-a)(x-b)}{(a-b)(a-c)(b-c)(x-a)(x-b)(x-c)}$$
$$= \frac{(b-c)(x^2 - bx - cx + bc) - (a-c)(x^2 - ax - cx + ac) + (a-b)(x^2 - ax - bx + ab)}{(a-b)(a-c)(b-c)(x-a)(x-b)(x-c)}$$
$$= \frac{bx^2 - b^2x + b^2c - cx^2 + c^2x - bc^2 - ax^2 + a^2x - a^2c + cx^2 - c^2x + ac^2 + ax^2 - a^2x + a^2b - bx^2 + b^2x - ab^2}{(a-b)(a-c)(b-c)(x-a)(x-b)(x-c)}$$
$$= \frac{a^2b - a^2c + ac^2 - ab^2 + b^2c - bc^2}{(a-b)(a-c)(b-c)(x-a)(x-b)(x-c)}$$
$$= \frac{(a-b)(a-c)(b-c)}{(a-b)(a-c)(b-c)(x-a)(x-b)(x-c)}$$
$$= \frac{1}{(x-a)(x-b)(x-c)}. \quad \text{Ans.}$$

Note.—Your writing is *pretty good*, but it is too thick.

4. J. WILSON.—The hold of a vessel partly full of water (which is uniformly increased by a leak) is furnished with two pumps worked by A and B, of whom A takes 3 strokes to B's two, but four of B's are equal to five of A's. Now B works for the time in which A alone could have emptied the hold. A then pumps out the remainder, and the hold is cleared in 13 hrs. 20 min. Had they worked together the hold would have been emptied in 3 hrs. 45 min., and A would have pumped out 100 gallons more than he did. Required the quantity of water in the hold at first, and the horary influx at the leak. (*Wood*).

Let x = No. of gals. pumped out by A in an hour,
Then, $x \times \frac{2 \times 5}{3 \times 4}$ or $\frac{5x}{6}$ = No. of gals. ,, ,, B ,, ,,
And let y = ,, ,, in hold at first,
Also ,, z = horary influx at the leak in gals. ;
$\therefore \frac{y}{x-z}$ = No. of hours in which A alone could have emptied the hold.

$$\therefore (1)\ \left(\frac{5x}{6} \times \frac{y}{x-z}\right) + x\left(13\tfrac{1}{3} - \frac{y}{x-z}\right) = y + (z \times 13\tfrac{1}{3})$$
$$(2)\ \left(x + \frac{5x}{6}\right) \times 3\tfrac{3}{4} = y + (z \times 3\tfrac{3}{4})$$
$$(3)\ x\left(13\tfrac{1}{3} - \frac{y}{x-z}\right) = (x \times 3\tfrac{3}{4}) - 100$$

$$(1)\ \frac{5xy}{6(x-z)} + \frac{40x}{3} - \frac{xy}{x-z} = y + \frac{40z}{3}$$
$$-\frac{xy}{6(x-z)} = y + \frac{40z}{3} - \frac{40x}{3}$$
$$\frac{xy}{x-z} = 80x - 6y - 80z. \quad (4).$$

$$(2)\ \frac{11x}{6} \times \tfrac{1}{2} = y + \frac{15z}{4}$$
$$\frac{55x}{8} = y + \frac{15z}{4}$$
$$55x - 8y - 30z = 0. \quad (5).$$

$$(3)\ \frac{40x}{3} - \frac{xy}{x-z} = \frac{15x}{4} - 100$$
$$-\frac{xy}{x-z} = \frac{15x}{4} - \frac{40x}{3} - 100$$
$$\frac{xy}{x-z} = \frac{115x + 1200}{12}. \quad (6).$$

From (4) and (6) ;

$$\therefore 80x - 6y - 80z = \frac{115x + 1200}{12}$$
$$960x - 72y - 960z = 115x + 1200$$
$$845x - 72y - 960z = 1200$$
$$(5)\ 55x - 8y - 30z = 0$$

$$\left.\begin{array}{r} 845x-72y-960z=1200 \\ 495x-72y-270z=0 \end{array}\right\}$$
$$350x-690z=1200$$
$$35x-69z=120$$
$$\therefore z=\frac{35x-120}{69}$$

$$\left.\begin{array}{r} 845x-72y-960z=1200 \\ 55x-8y-30z=0 \end{array}\right\}$$
$$\left.\begin{array}{r} 845x-72y-960z=1200 \\ 1760x-256y-960z=0 \end{array}\right\}$$
$$-915x+184y=1200$$
$$\therefore y=\frac{915x+1200}{184}$$

(6) $$\frac{xy}{x-z}=\frac{115x+1200}{12}$$
$$\frac{x(915x+1200)}{184}=\frac{115x+1200}{x-\frac{35x-120}{69}}$$
$$\frac{915x^2+1200x}{\frac{8}{69x-35x+120}}=\frac{115x+1200}{12}$$
$$\frac{3(915x^2+1200x)}{8(34x+120)}=\frac{115x+1200}{12}$$
$$\frac{2745x^2+3600x}{2(34x+120)}=\frac{115x+1200}{3}$$
$$8235x^2+10800x=(115x+1200)(68x+240)$$
$$=7820x^2+109200x+288000$$
$$415x^2-98400x=288000$$
$$x^2-\frac{19680x}{83}=694\frac{80}{83}$$
$$x^2-\frac{19680x}{83}+(9\frac{84}{83})^2=694\frac{80}{83}+\frac{96825600}{83^2}$$
$$=\frac{4780800+96825600}{83^2}$$
$$=\frac{101606400}{83^2}$$
$$x-9\frac{84}{83}=\pm 1008\frac{40}{83}$$
$$x=\frac{\pm 10080+9840}{83}$$
$$\therefore x=240, \text{ or } -\frac{240}{83}.$$

The minus value is inapplicable.

$$y=\frac{915x+1200}{184}$$
$$=\frac{(915\times 240)+1200}{184}$$
$$=\frac{219600+1200}{184}$$
$$=\frac{220800}{184}$$
$$=1200.$$

$$z=\frac{35x-120}{69}$$
$$=\frac{(35\times 240)-120}{69}$$
$$=\frac{8400-120}{69}$$
$$=\frac{8280}{69}$$
$$=120.$$

∴ Quantity of water in hold at first = 1200 gals.
Horary influx at the leak = 120 gals.

5. VERAX II.—In how many ways can a bill of £1 9s. be paid in florins and half-crowns? (*Hamblin Smith.*)

Let x = No. of florins,
And ,, y = ,, half-crowns;

Then, $$2x+\frac{5y}{2}=29$$
$$2x=29-\frac{5y}{2}=\frac{58-5y}{2}$$
$$\therefore x=\frac{58-5y}{4}.$$

The integral values of y that give integral values of x, are
$y=2$, then $x=12$,
$y=6$, ,, $x=7$,
and $y=10$, ,, $x=2$;
∴ There are 3 ways, viz.,
12 florins and 2 halfcrowns,
7 ,, 6 ,, ,
and 2 ,, 10 ,, .

Note.—Whenever possible, give the answers to your queries.

6. DENNY, Leamington.—A person with a capital of £a, for which he receives interest at r per cent., spends every year £b, which is more than his original income. Find in how many years he will be ruined.

Ex.—If $a=1000$, $r=5$, $b=90$, show that he will be ruined before the end of the 17th year, having given
log 2 = ·3010300, log 3 = ·4771213,
log 7 = ·8450980. (*Todhunter.*)

The present value of an annuity of £b per year is $\frac{b(1-R^{-n})}{R-1}$; it is obvious that the man is ruined if this is greater than a, that is, if $b(1-R^{-n})$ is greater than $a(R-1)$. In this case, $b=90$, $R=\frac{21}{20}$, $a=1000$; thus the man will be ruined if
90(1 − R⁻ⁿ) is greater than 1000 ($\frac{21}{20}$ − 1),
that is, if 9(1 − R⁻ⁿ) is greater than 5,
if 1 − R⁻ⁿ ,, ,, $\frac{5}{9}$,
that is, if R⁻ⁿ is less than $\frac{4}{9}$;

We have then to show that $\frac{1}{R^n}$ is less than $1\div\frac{9}{4}$, that is, that R^n is greater than $\frac{9}{4}$, when $n=17$.

$$\text{Log } R^{17}=17 \log R=17 \log \tfrac{21}{20}=17(\log 21-\log 20)$$
$$=17(\log 7+\log 3-1-\log 2)$$
$$=17(\cdot 8450980+\cdot 4771213-1-\cdot 30103)$$
$$=17\times \cdot 0211893$$
$$=\cdot 3602181;$$
$$\log \tfrac{9}{4}=\log 9-\log 4=2\log 3-2\log 2$$
$$=(\cdot 4771213\times 2)-(\cdot 30103\times 2)$$
$$=\cdot 9542426-\cdot 60206$$
$$=\cdot 3521826;$$

∴ He will be ruined before the end of the 17th year.

7. SUBSCRIBER.—The sum of £15,050 is divided between A and B. A's money is invested in the 3 per cents. at a certain price; B's money, which exactly equals A's amount of stock, is also invested in the 3 per cents. when the price has risen £3, and B's annual income is £87 10s. more than A's. Find each investment. (*Colenso.*)

Let x = A's money,
and ,, y = price of stock;

Then, (1) $$\frac{100x}{y}=15{,}050-x$$
(2) $$3\left(\frac{15050-x}{y+3}-\frac{x}{y}\right)=87\tfrac{1}{2}$$

(1) $$100x=15{,}050y-xy$$
(2) $$3\left\{\frac{15050y-xy-x(y+3)}{y(y+3)}\right\}=1\tfrac{7}{8}$$

(1) $xy=15{,}050y-100x$
(2) $6(15050y-xy-xy-3x)=175y(y+3)$
$90{,}300y-12xy-18x=175y^2+525y$
$89{,}775y-12(15{,}050y-100x)-18x=175y^2$
$89{,}775y-180{,}600y+1{,}200x-18x=175y^2$
$1{,}182x-90{,}825y=175y^2$

From (1) $$x=\frac{15050y}{y+100}$$
$$\therefore \frac{15050y\times 1182}{y+100}-90{,}825y=175y^2$$

Dividing by 175y:
$$\frac{86\times 1182}{y+100}-519=y$$
$$101{,}652-519y-51{,}900=y^2+100y$$
$$y^2+619y=49{,}752$$
$$y^2+619y+(309\tfrac{1}{2})^2=49{,}752+95{,}481\tfrac{1}{4}$$
$$=\frac{199008+383161}{4}=\frac{582169}{4}$$
$$y+309\tfrac{1}{2}=\pm 763\tfrac{1}{2}$$
$$y=\pm 763\tfrac{1}{2}-309\tfrac{1}{2}=72, \text{ or } -691.$$

The minus value is inapplicable.

$$x=\frac{15050y}{y+100}=\frac{\overset{350}{\cancel{15000}}\times 72}{\underset{172}{\cancel{172}}}=6{,}300.$$

∴ B's investment = £6,300,
And A's ,, = £15,050 − £6,300
= £8,750.

Note.—'The Teachers' Prayer Book,' published by Messrs. Eyre and Spottiswoode.

8. YELSERP.—A set out to walk from London to Rugby, and B at the same time from Rugby to London, a distance of 84 miles, and A reached Rugby 9 hours, and B reached London 16 hours, after they met on the road. Find in what time each performed the journey, and their rates of walking, supposed uniform.

Let x = A's rate per hour in miles,
And " y = B's " " " ;
Then, (1) $9x+16y=84$
(2) $\frac{9x}{y}=\frac{16y}{x}$

(1) $16y=84-9x$
$\therefore y=\frac{84-9x}{16}$

(2) $9x^2=16y^2$
$=16\left(\frac{84-9x}{16}\right)^2$
$=\frac{7056-1512x+81x^2}{16}$

$144x^2=7056-1512x+81x^2$
$63x^2+1512x=7056$
$x^2+24x=112$
$x^2+24x+(12)^2=112+144$
$=256$
$x+12=\pm16$
$x=\pm16-12$
$\therefore x=4$, or -28.

The minus value is inapplicable.

$y=\frac{84-9x}{16}=\frac{84-36}{16}=3.$

$\therefore$ A's rate of walking per hour = 4 miles
B's " " = 3 "

A performed the journey in $\frac{84}{4}$ hours = 21 hours
B " " $\frac{84}{3}$ " = 28 "

Note.—About 90 per cent.

9. C. C.—Solve :—

$x+2y+3z=14$
$3x+4y+5z=26$ } (*Matriculation.*)
$4x+3y+2z=16$

Although three equations are given, there are in reality only two, as any one of them can be formed from the other two, and therefore the equations are indeterminate.

Thus, adding (1) and (3),

$5x+5y+5z=30$
$x+y+z=6$
$2x+2y+2z=12$
(1) $x+2y+3z=14$
$3x+4y+5z=26$ (2)
(1) $x+2y+3z=14$
$x+y+z=6$
$y+2z=8$
$z=\frac{8-y}{2}.$

The positive integral values of y, that give positive integral values of x, are

(1) $y=2$, then $z=3$;
(2) $y=4$, " $z=2$;
(3) $y=6$, " $z=1$;
$x+y+z=6$,
From (1), $x=1$
" (2), $x=0$
" (3), $x=-1$

$\therefore$ The positive integral values are :—

$x=1, y=2, z=3,$
And $x=0, y=4, z=2.$

General.

1. G. NELIAN.—'Ellen or *me*,' in apposition to '*whom*,' object of '*likes*.' 'She does not know whom she likes the better of the two, Ellen or me.'

2. J. R. ROBERTS.—No Latin author is specified for Q. S. examination. See last year's questions to judge of their difficulty.

3. CANDIDATE.—We repeat what we have said several times, that no religious knowledge examination paper is set in July by the Education Department. But each college has its own arrangement as to this subject, the particulars of which may be obtained with the terms of admission. Some papers of the Church colleges are published by the National Society.

4. PRAECEPTOR'S writing would pass, but his large hand is evidently 'unstudied.' As to the Latin, see answer given above (2).

5. EMPEROR might get some help from *Tancock's* 'England,' from 1765 to 1820; and *Browning's* 'Modern England,' from 1820 to 1874. Both are included in 'Epochs of English History,' published by Longmans (9d. each). 'The History of our Own Times,' by *Justin M'Carthy*, is a much larger work.

6. Y WYDDFA will perhaps find some help in *Dr. Morell's* 'Practical Introduction to English Composition,' published by Stewart. But the language must be known before it can be used.

7. WELSHMAN will be admitted to a 'Church college' not on the ground of passing the Scripture examination only. There are personal qualifications respecting health, etc., which he should ascertain by obtaining the terms of admission from the principal.

8. CYMRO DEWR.—About eighty per cent. The writing is evenly good.

9. TOM.—You will find the solution of your query in our issue for June, 1882.

10. GEORGIUS.—(1) Arrange the multiplicand, multiplier, and product according to descending powers of a or x, or as the case may be. (2) We believe your writing would obtain full marks at an examination.

11. CARLO.—The solution of your query appeared in our issue for June, 1882.

12. ALPHA.—Can any reader of the P. T. give me the name, publisher, and price of any dictionary or other work that will render me any assistance in the study of *Sir David Lyndesay's* 'Ane Satyre,' one of the English authors prescribed for the next Intermediate Arts' Examination of London University?

13. WALLACE.—The Syllabus of the Certificate Examination for 1884 was published in the *Schoolmaster* of December 22nd, 1883.

14. 'CICERO,' 'RALPHO,' 'COLLEGIAN,' and others whose queries arrived too late for the last issue, would nevertheless find answers in the replies given to several inquirers. In addition to the Epochs in English History, and *Justin M'Carthy's* 'History of our own Times,' we may name *Mackenzie's* 'History of the 19th Century.' The summary published by the *Times* is a useful chronological record. Candidates must confine themselves to *one* notation in writing music, but for the singing test either may be used. The exercises are distinct.

15. WIGTONIAN writes small hand legibly, but, like many others, has neglected to *study* the forms of letters for large hand. Parsing is called functional because words are thereby classified according to the function (or office) of each in a sentence: *e.g.*, *names* are *nouns*, etc.

16. F. G. H. writes firmly but not evenly. The Scripture questions are the same in many Church Training Colleges: enquire of the National Society, Westminster. The English Constitution, etc., by Sheldon Amos, may be useful. For this and English Dictionaries, see advertisements.

17. DESIROUS may select *any* 80 lines, according to the taste of the P. T. But let it *be* poetry, and not mere rhyme.

18. A. T. may have seen the statement repeatedly made that the marks assigned to each subject are not now published as formerly. Writing lacks freedom; not more than sixty per cent.

19. E. H. G. must also study his capitals; looped letters should not exceed them in height. Perhaps seventy.

20. R. R. F.—'Unseen' passages in Latin and French. Marks not known.

21. CZECH should get Morris or Daniel (Part III.). These grammars have been named before.

22. NECKER, after having obtained his parchment certificate, is technically 'free'; but if he has bound himself by any implied engagement to continue his services, he will remember that a teacher should be the most honourable of men.

23. G. H. A. TAYLOR.—The Code (Art. 68) prescribes an interval of two years for 're-examination' in order to raise your certificate. *Hullah's* 'Time and Tune' will serve your purpose.

24. D. M. H. is right in supposing that 'Mulhauser's System of Writing' is out of print. Canon Richson, of Manchester, has published some valuable sheets, etc., on this subject.

25. LITERATURE will find the Clarendon Press edition of Shakespeare's Richard II., and Lewis's edition of Bacon's Essays, sufficient. Dr. Abbott has also annotated the Essays (two vols., Longmans).

26. COTTONOPOLIS.—The Q.S. Examination has reference to admission for the next year's course at the College. It does not stand good for *any* subsequent year. But you may sit in successive years until you reach the top of the list, if you desire to do so. Your small-hand must be more regular.

27. ROGO.—James' book or James's book; both forms are used in writing. For Scripture questions write to the Secretary, National Society, Westminster.

28. J. F. M. BRYN.—We know of no such work.

29. EL TEB.—Custom-House officers if on duty at night, are off duty during the day. With a few special exceptions, they receive no extra pay.

30. SOLICITOR.—(*a*) 'Draw near and listen to the decision of our council:—In order that the blood of those whom this country hath bred may not be made to stain the ground; and because we hate the sight of wounds received in civil strife between neighbours; and because we think it is only pride which springs from ambition, and envy of ourselves and each other that hath stirred you up to disturb the quiet of our realm—a quiet so lately secured that if now rudely broken by the clash of arms, and all the sounds and circumstances of war, the peace of the kingdom might be completely destroyed, and the country deluged with blood,—we therefore banish you from the realm,' etc.

(*b*) No; we cannot afford the space, especially as text-books, fully annotated and published at so cheap a rate, can be procured for the purpose.

31. PUPIL TEACHER.—Your query was fully solved in our last issue, and an explanation given of scales of notation. See No. 3 in Algebra.

32. M. D.—The solution of your query appeared in our issue for May, 1882.

33. J. HEAVY HAND.—(*a*) Your writing is uneven, and many of the letters are incorrectly formed, the capitals in several places being poor. It is, however, bold and round, and with daily practice in a good copy book, will soon be a good hand.

(*b*) *A*—distinguishing adj., limiting '*few minutes*,' considered as a whole.
few—a common noun, neut., sing., obj., gov. by 'have.' a few = some, or '*a few*' = a number.
minutes—com. noun, pl., neut., obj., gov. by 'of' understood.
welcome—adj. of quality, qualifying 'you,' or person understood.

34. YOUNG GRAMMARIAN.—

Darkened—past part. of 'to darken,' referring to 'Archangel.'
so—adv. of manner, modg. 'darkened.'
above—prep., showing rel. between 'them' and 'shone.'
waiting—pres. part. of 'to wait,' refg. to 'brows.'
revenge—abs. noun, neut., sing., 3rd, obj., gov. by 'for,' understood.
cruel—adj. of quality, qual. 'eye.'
eye—com. noun, neut., sing., 3rd, nom. to 'was cruel.'
cast—irreg. trans. verb, act., ind., past., 3rd, agreeing with its nom. 'it' understood.
rather—adv. of deg., modg. 'should say,' in the sentence '*I should rather say they were the followers.*'
far—adv. of deg., mod. 'other.'
other—indef. adj., qual. 'beings' understood.
once—adv. of time, modg. 'beheld.'
beheld—past part. of 'to behold,' refg. to 'fellows.'

(The clause may be thus expanded: *They were* far other (entirely different) *beings* once, *when they were* beheld in bliss.)

condemned—past part. of 'to condemn,' refg. 'to fellows.'
for—prep., showing reln. between 'ever' and 'condemned.'
ever—adv. used as com. noun, neut., sing., 3rd, obj., gov. by 'for.'
now—adv. of time, modg. 'condemned.'

SENTENCE.	KIND OF SENT.	CONNECTIVE.	SUBJECT.	PREDICATE.	OBJECT.	EXTENSION OF PRED.
(*a*) Darkened so, yet shone above them all the Archangel.	Princ. Sent.		The Archangel, darkened so	shone		yet (time) above them all (manner)
(*b*) but his face deep scars of thunder had intrenched	Princ. Sent. adversative to (*a*)	but	deep scars of thunder	had intrenched	his face	
(*c*) and care sat on his faded cheek	Princ. Sent. co-ord. to (*b*)	and	care	sat		on his faded cheek (place)
(*d*) but under brows of dauntless courage and considerate pride waiting revenge	Princ. Sent. adversative to (*c*)	but	[it]	[sat]		under brows of dauntless courage and considerate pride, waiting revenge (place)
(*e*) cruel his eye	Princ. Sent.		his eye	[was] cruel		
(*f*) but cast signs of remorse and passions to behold the fellows of his crime, the followers rather (far other once beheld in bliss) condemned for ever now to have their lot in pain.	Princ. Sent. adversative to (*e*.)	but	[it]	cast	signs of remorse and passions	to behold the fellows of his crime, the followers rather, (far other once beheld in bliss) condemned for ever now to have their lot in pain (reason)

35. A CONSTANT READER.—The only difficulty in the line you require to be parsed is in the word 'wreck,' which may be taken in several ways. If there is a dash between *vessel* and *wreck*, then the latter word is objective case, in apposition with *vessel*. If not, then the sentence may be considered elliptical, and the ellipsis supplied thus: Drive the vessel *till she becomes* a wreck, or, Drive the vessel *which is* a wreck. Then wreck would be nominative case after *becomes* or *is*.

36. VESUVIUS.—At the foot of (Mt.) Vesuvius the country is the finest and the best-cultivated that can be found in the kingdom of Naples, that is to say, in the country of Europe, (which is) the most favoured of heaven. The celebrated vine whose wine is called *Lacryma Christi*, is found in this place, and quite close to (beside) the lands devastated by the lava. One would say that nature has made a last effort in this place adjoining the volcano, and has robed (adorned) herself in her most beautiful gifts before perishing. As one rises, one discovers, on turning round, Naples and the admirable country which surrounds it. There the splendour of creation is diminished by degrees as far as (until we reach) the land (region) of cinder and of smoke, which announces (indicates) beforehand the approach to the volcano. The lavas of preceding years trace on the soil their broad and black furrow, and all is bare (barren) around them. At a certain elevation (the) birds do not (no longer) fly; at another, plants become very rare. Then the very insects no longer find anything to subsist (upon) in this burnt-up nature. At length all that has life disappears; you enter the empire of death, and the cinder of this pulverised land alone rolls under your badly-stayed (unsteady) feet. Never does the shepherd nor the herdsman lead to this spot (place) either his (their) sheep or his herds (cattle). [This translation is nearly literal, as desired.]

37. PORTLAND.—Writing lacks care and firmness; about sixty per cent.

38. CÆSAR.—See answer to Cicero and others (14).

39. LEO can gain little from books. There must be the actual training of the voice. Elocution cannot be secured by rules merely, although these may be suggestive.

40. EIFIONFAB.—'The Science and Art of Teaching,' National Society. Writing fairly uniform; about seventy-five per cent.

41. EDWAL.—The books named will suffice if mastered.

42. READER.—In England students in training are resident, but not in Scotland. There are no 'day-pupils.'

43. COMPO.—The marks assigned to the several subjects are not known. A science, a language, and drawing, each adds to the marks to lift a candidate towards the top of the list.

44. ANXIOUS ONE can obtain a Colonial Certificate only in the colony itself. Study the formation of capitals; you may obtain sixty per cent.

45. REVILO NYLEWELL.—'Power of pen' certainly, and very regular; but the style is not the best, and would fall short of 'full marks.'

46. E. S. W.—Could you not rule three lines in the margin for the three odd days? Entries might be inserted with care in the Summary. The new Registers will begin on Thursday, May 1st. It would be better to paste on a slip in the old Register than end the year with three days in the new.

47. THOMAS CARTWRIGHT.—*Sully's* 'Psychology,' 12s. 6d. (Longmans). Many thanks for information.

[Any subscriber to the PRACTICAL TEACHER having Vol. I. to dispose of (bound or unbound), please address—'J. A., 116, Chapman Street, Great Grimsby.']

*** *Several queries are unavoidably crowded out.*

Publications Received.

Bell and Sons—
The Romance of the Coast. By P. Runciman.
Great Englishwomen.
The Light of Truth and other Parables from Nature. By Mrs. Alfred Gatty.
Enunciation of Propositions in Geometrical Conic Sections. By W. H Besant, M.A., D.Sc., F.R.S.
Formulæ and Equations. By Rev. T. W. Openshaw, M.A.

Blackie and Son—
Blackie's Graded Readers, Primers, Parts. I and II., and Complete, and Standards I. to VI.
Blackie's Comprehensive Readers, Primers, and Standards I. to VI.
Blackie's Geographical Readers. Nos. 1 and 2.

Chambers (W. and R.)—
Chambers' Historical Reader. Book II.

Grant and Co.—
How to Manage Schools. By H. Major, B.A., B.Sc.

Heywood (John)—
John Heywood's Infant Primer.

Hodder and Stoughton—
Capital for Working Boys. By J. E. McConaughty.

Isbister (W.), Limited—
The New London Readers. No. 6.

Johnston (A.)—
Johnston's Standard Diagrams of Physiography. Nos. 1 and 2 on rollers.
Johnston's Pictures for Schools. Fruit-trees: Apple, Cherry, Pear, Date, Plum, Orange.

Ledsham (J. B.)—
Ledsham's Essay Cards. By E. Noble.
Notes on Commercial Geography. By the Rev. L. C Casartelli, M.A.
Varied Occupation Cards for Infant Classes.

Letts, Son, and Co.—
Letts's Illustrated Household Magazine. Part XIII. March.

Lewis (H. K.)—
A Comprehensive Manual of Elementary Knowledge. By J Oberlin Harris, M.A.

Longmans and Co.—
Lays of Ancient Rome. (Annotated.)
Longman's Magazine. March.
Swift's Gulliver's Travels. "Longman's Modern Series.

Macmillan and Co.—
The English Illustrated Magazine (March).

Moffatt and Paige—
Notes on School Management. By G. Collins.

Morris (John), Chicago—
Opinions of the American Press on Mr. Henry Irving and Miss Ellen Terry.

Nelson (T.) and Sons—
Handy Register of Daily Attendance and Fees.
The New Royal Readers. No. 3.

Simpkin, Marshall, and Co.—
A Summary of English History. By L. G. Burt.
Chemical Tables for Elementary Students. By Wm. Joel Kemp.

Smith, Elder, and Co.—
The Cornhill Magazine for March.

Swan Sonnenschein and Co.—
The Naturalist's World. January, February, and March.

Systematic Bible Teaching Co.—
The Gospel Manual, Grade III.

The Educational Supply Association—
Robinson Crusoe.
1st, 2nd, and 3rd Standard Spelling Books. By G. T. Taylor.
The Eclipse Test Cards. Standards II. to VII.
The Holborn Atlas.

The National Society—
Shakspeare's Plays for Schools. King Richard II. and King Henry V. By C. M. Yonge.

Ward, Lock, and Co.—
The Universal Instructor. Part XLI.

Williams and Norgate—
The Child's First German Course. By E. Schinzel.
A German Preparatory Course. By E. Schinzel.
German Conversational Questions. By E. Schinzel.
German Method. By E. Schinzel.

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The February (1884) number of the *Practical Teacher* is now out of print.

Matriculation Hints.

BY HENRY A. REATCHLOUS, M.A. (LOND.), B.Sc.,

Westminster Training College.

In this and subsequent papers we propose to give some help and instruction to students reading for the matriculation examination of the University of London. Though the standard is believed to be fully maintained, this examination has lost none of its popularity. We learn from the calendars that about 1,600 candidates are examined annually, of whom about one-half are rejected. It appears, however, that some subjects are more fatal than the rest: thus, taking the average of six examinations, 25 per cent. failed in Latin, 26 per cent. in Greek, 16 per cent. in French, 8 per cent. in German, 23 per cent. in mathematics, 13 per cent. in English, 27 per cent. in natural philosophy, and 13 per cent. in chemistry. These figures are only averages, and may not hold good for the next examination, but they are instructive. It is plain there are some subjects in which it is more difficult to satisfy the examiners than in others. These subjects must be studied with special care from the first. Many, no doubt, will ask, what are the chances of success? how much preparation is needed? In reply, it may be said, once for all, that without fairly good abilities and habits of systematic and persevering application, the prospects of success are not very bright. No great proficiency in any single subject is required, but there are a good many subjects, and experience shows how easy it is for a candidate to fail to satisfy the examiners in some of them. To be sure of passing, one must know the work well all round. This is impossible without diligence and perseverance; to say otherwise would lead to disappointment.

It will, no doubt, be interesting to our readers to learn that the total number of marks obtainable is 2,800; 2,000 qualify for a prize; 1,800 for honours; and 1,400 for a place in the first division. All the papers carry an equal number of marks, except the two Latin papers. No candidate can pass who does not satisfy the examiners in Latin, Greek (*or German*), French, Mathematics, English, Natural Philosophy, and Chemistry. It is believed that one-third of the marks obtainable in each subject will secure a pass, but the candidate must not rely on this; he will be sure to fail unless he aims at doing very much more. But having secured a pass, the next object should be to get a good place on the list. As this depends on the total number of marks, and as Chemistry carries as many as Greek, it is foolish to neglect any individual subject, or leave the room, as many candidates do, as soon as they have done as much as they think will just secure a pass. Strive to do each paper equally well.

Latin.—It has been already stated that about one quarter of the candidates fail in Latin. As many of them have been well grounded in it from the first, and therefore pretty sure to pass, it is plain that of those who take up Latin with little or no assistance, after leaving school, the percentage of failure must be very great indeed.

In Latin, as in everything else, a student can do much for himself; the more the better. With books, like Smith's 'Principia' (Parts I. and II.) and Abbott's 'Via Latina,' a book in which every exercise is made with a purpose, a good deal of progress can soon be made. The accidence, vocabularies, rules, and examples can all be mastered nearly as well without help as with it. But to learn to translate Latin into good English is not quite so easy. Much of what passes as translation can scarcely be called English at all. 'The elements of composition are not so much words as phrases, and the English equivalents for these must be found.'

It will be seen, however, that stress is laid on the correct rendering of English into Latin. It would be too much to say that a candidate cannot possibly

learn enough Latin composition by himself to pass the examination; with Arnold's 'Latin Prose Composition,' and the key to it, he might possibly do so. But we persuade him not to try. By all means get a few lessons in Latin composition from a thoroughly competent person, and have your exercises corrected if possible in your presence. Another part of the examination that needs to be borne in mind, is the translation of passages from books not prescribed. Attempt some easy pieces every week. There are plenty of reading books that will answer the purpose. Passages will appear also in these pages as monthly tests. Here are two:—

Vir est virtutis spectatæ, me pœnitet autem vos eum ducem fecisse quia prudentia virtuti impar est et prudentiæ sapientia.

Expugnata Carthagine Scipio circa Siciliæ civitates litteras misit, ut ornamenta templorum suorum a Pœnis rapta per legatos recuperarent inque pristinis sedibus reponenda curarent.

The student who has not begun Greek should consider whether it would not be better to take German. In reading for a degree in science, the ability to read German is of the utmost importance. But if the candidate means to proceed to a degree in arts, he will, of course, take up Greek. Smith's* 'Initia Græca' is a good book for a beginner. It would, no doubt, be well to join a class, and in large towns this becomes more and more easy to do. In many cases private assistance can be got from some educated friend. An earnest student does not require much help, and if it is quite out of reach, he need not despair. *Festina lente*—go slowly—should be the motto all through, but especially at first. Twenty minutes three times a day ought to secure excellent results. Write out all the new words and say them aloud. The forms of the article, nouns, and adjectives must be repeated hundreds of times; they should be occasionally written out, and then compared with the book. A noun and an adjective should be declined together. Such exercises often form part of the questions on grammar.

There is a book which should be used in connection with the 'Initia Græca' from the first. It is so specially adapted to the student's needs, that he must get it at once, and use it every day. It is Rushbrooke's 'First Greek Reader.' We have never known a candidate to fail in Greek, who has carefully studied this excellent book. It is of the utmost importance that the 'unseen passages' should be fairly done. It is not stated officially that this is imperative. But as a man who is weak in Greek will be sure to omit them, or only manifest his ignorance in attempting them, it is easy to see that this part of the examination may show more clearly than almost any other whether a candidate should pass or fail.

A careful use of Rushbrooke's 'First Greek Reader' will make a good examination in this part of the subject certain. There should be no hurry about reading the books prescribed. Of all the unprofitable and repulsive work, surely none is equal to that of trying to read a Greek author before one is fairly prepared for it. Be content to go slowly. Get through most of the 'Initia' and the 'Greek Reader' before attempting the author. Reading will then bring both pleasure and profit.

The subjects included in the paper set on Natural Philosophy are found to give considerable trouble. The paper is now divided into two sections. The candidate must take some questions in section A, and he may confine himself exclusively to them. It is, therefore, very necessary to study some of the many text-books on Mechanics. There is no need to insist on any particular book. We need only mention the names of Newth, Aveling, Magnus, Todhunter, Wormell.

We will return to some of the subjects of the Natural Philosophy paper in detail next month.

(To be continued.)

* A Key may possibly be obtained from the publishers by a *bona fide* private student.

Publications Reviewed.

Principles of Hygiene. By Albert Carey F.R.G.S. London: Thomas Murby.

This little book has been composed with a view to the requirements of the Science and Art Department at South Kensington, on the syllabus of which it is modelled. It is simply and clearly written, and is remarkably free from wordiness. The various branches of hygiene are considered in turn, and the more important principles briefly stated; so that the book may be said to give a fair, though necessarily somewhat meagre outline of a very extensive and important subject. We are, however, sorry to notice a number of errors and inaccuracies which considerably impair its value as a trustworthy elementary text-book.

Thus, in chapter i. we find albumen stated to be identical with the serum of the blood, whereas this contains fats and other bodies in addition to serum-albumin. Moreover, the elementary composition of nitrogenous food-principles is not given, although in the next section that of fats and amyloids is alluded to. In the chapter on Diet, too, absolute adhesion is given to Liebig's division of foods into heat-formers and tissue-formers, which is only true with certain limitations. In chap. xi. we are informed that a gallon of ordinary drinking-water contains from two to three cubic inches of hydrogen gas dissolved in it, instead of nitrogen—a mistake which might easily confuse those with a limited knowledge of chemistry. Further on (chap. xv.) it is stated that tea may be 'partly a substitute in badly-fed persons for the nitrogen in animal food.' When we remember the very small proportion of nitrogenous matter dissolved in a gallon of tea, its value as a substitute for butcher's meat will appear very problematical. It is scarcely correct to affirm that theobromine is identical with caffeine, as the formulæ differ by CH_2.

The chapter on Fermented Drinks is spoiled by the introductory paragraph, which would lead the student to conclude that all bodies (such as albumen) which readily undergo decomposition, induce similar changes in more stable bodies, no mention being made of the important part played by certain living organisms in many of these processes. The next chapter, which continues the subject, contains a most extraordinary definition of the peritoneum (which, by the way, is wrongly spelt). In the division treating of air and respiration, the quantity required per hour is somewhat understated. Further, the amount of air deprived of its oxygen by the combustion of one pound of oil is given as thirteen cubic feet instead of over 130; and carburetted hydrogen gas is stated to be present in the atmosphere in the proportion of ·047° which is absurd. In the section on the treatment of those rescued from drowning, we should have been glad to see a less prominent place assigned to the Marshall Hall method, which is now almost entirely abandoned in favour of Sylvester's or Howard's. It would have been well to have added a caution as to the indiscriminate use of emetics in cases of poisoning by corrosives, in which they might sometimes do more harm than good. We

have been sorry to have to call attention to these blemishes in an otherwise excellent little manual; and we still believe that it may by careful revision be made to take a satisfactory place among the numerous similar works which are now competing for the public favour.

Education and Educators. By David Kay, F.R.G.S. London: Kegan Paul & Co.

This book has an attractive title, and the synopsis of the contents tends still further to raise the reader's expectations. It is, however, a very disappointing volume. By far the bulk of the book consists of notes—quotations from other writers. For every word of Mr. Kay's printed in large type, there are at least ten of some other author's in small type at the foot of each page. He says, in his preface, with commendable modesty, that 'the chief value of the book lies in the notes'; but he adds that the text should 'be read by itself, and the notes only referred to when there is something that seems to require further elucidation or explanation.' Now, if he really supposes that every passage of his own to which he affixes a note requires more elucidation than he has given it, he must surely be conscious that his text deserves complete remodelling; for there is scarcely a sentence which is not annotated. If, on the other hand, he does believe the notes to be the valuable portion of the book, his text sinks into insignificance, and should be relegated to the small type, if not dispensed with altogether.

The fact is that Mr. Kay has made the mistake of not quite knowing what sort of a book he wished to produce. He has written perfunctorily and hastily upon a great variety of points, from hereditary transmission to the use of text-books in teaching, and from the importance of pleasing manners to the character of Divine revelation. Conscious, however, that he has only half-treated any of his topics, he seeks to make up for his omissions by emptying the contents of his commonplace book into his pages. The undigested, mixed mass which results has neither the merits of an original work nor those of a volume of elegant extracts. There is little satisfaction in reading the text, because no idea there broached is fully treated and properly concluded; there is less in reading the notes, for the quotations are too brief to have much meaning or value. We do not say that there is not any value in them, for even two lines from the writings of a thinker will be found suggestive, as diamond-dust will sparkle; but just as the value of a diamond is diminished with every cleavage, and comes nearest to nil when the gem is reduced to powder, so the thoughts of such men as Locke, Mill, Herbert Spencer, and Bentham, are depreciated by such unreasonable mutilation as that to which Mr. Kay submits them. A good selection of quotations on education would form a valuable book; but the quotations would have to be long enough to fully express the ideas. Moreover, it would be necessary for the compiler of such a work to avoid another error into which Mr. Kay has fallen, in overloading his pages with truisms and commonplaces. The finest grain must have a proportion of chaff; and, similarly, even great thinkers are obliged, in stating facts or conducting a train of argument, to put forward in due course their axioms and their commonplaces. But nothing can be gained by extracting these and re-dishing them all by themselves as quotations. The case is even worse when one finds some such every-day observation signed only with the name of that gentleman whom the old lady thought wrote most of the best bits in the poetry-books—Mr. 'Anon.' If all this dust were cleared from the pages of 'Education and Educators,' its bulk would be diminished, but its value would be multiplied.

We must now add that we think Mr. Kay capable of doing some useful work on his own account. We differ from him on many of the topics on which he indicates his opinion in this volume. They are not subjects suited for discussion in our columns; for when he speaks of 'Educators' he does not mean the eminent theoretical or practical teachers of the past or present, but uses the word in the far wider sense of 'whatever calls a faculty into exercise, and so trains or educates it.' His scheme, therefore, leads him very widely away from what is ordinarily meant by education—viz., school, or college, or tutorial teaching—and into fields where we, as teachers, cannot follow. Discussions on Capital and Labour, on the theories of Mill's Liberty, or on Divine Grace, do not come within our review here. But we may say that, however we disagree with some of Mr. Kay's conclusions on such points, still his method of treating them is such as to lead us to believe that he might write much more usefully than he has done here. In order to do so, he must throw away his crutches—his notes. Let him gather ideas from his commonplace book, but let him not make use of it to excuse himself from thoroughly writing out his subject from his own mind; and he may yet do some excellent work. The composition of this book is scholarly, the author's reading evidently covers a wide range, and his tone is earnest and sincere.

School Management and Method in Theory and Practice, etc. By John J. Prince. Manchester: John Heywood.

This book is written by a practical teacher who has kept his eyes open while about his daily work. Having mastered its details, and acquired definite ideas regarding the several departments and processes of school-keeping, he here presents the results of his observations and practice for the help of young teachers and others, 'intending to sit at the scholarship or certificate examinations.' The book fully justifies the assertion in the preface, that 'it is practical in the full sense of the word.' It is one of a useful class of books which have come thickly upon us of late, written by workers, for workers, and especially to enable candidates 'to answer successfully the questions which may be proposed to them at the examinations for scholarships and certificates.'

Such books, when well written, serve a useful purpose. They deal with the art and practice of school instruction and management, and they give the information needed for answers to the questions proposed at the examinations. Written less for the purpose of setting forth a true standard of education than of meeting the requirements of the Code, they do not, as a rule, present a view of the science of education in its broader aspects, nor indicate the principles, save incidentally, on which true methods of instructing and of training children depend.

Many who take up the profession of teaching limit their aims to the acquirement of just as much knowledge of school work as will enable them to satisfy the conditions of public elementary school teaching. As a guide to the reaching of such a standard this book seems well adapted. It contains much information, and some thoughtful and intelligent observations on the several matters comprised in the work of a day-school teacher, for the most part sensibly and clearly put. It also indicates, with much directness and precision, methods and rules for the management and teaching of children, which have been found effective in practice, and which characterise many successfully-conducted schools.

The matter is arranged in four parts: I. School Management; II. Method; III. Investment of Savings, Building Societies, Sanitary Science; IV. Examination Questions, with Hints and Answers.

The chapters in Part I. deal successively with the schoolroom, organisation, registration, and discipline. The practical good sense characteristic of the book marks *most* of what is given under these heads. There are, however, some doubtful exceptions. Thus, in section 36 (pp. 47-8), headed 'Cleanliness and Neatness,' there occurs this direction, oddly worded, and of questionable propriety: 'The children old enough to keep themselves clean, should be always kept in, similar to late scholars, for about three-quarters of an hour, and *not permitted either to speak or move*.' (The italics are ours.)

Again, some good counsel regarding corporal punishment is followed by this statement: 'The front of the hand is the only part upon which the punishment

should be inflicted.' In view of the nature of the punishment itself, of its emphatic condemnation by many medical authorities, and of numerous recent magisterial decisions, it may at least be urged that this *dictum* should be received with the greatest possible caution.

Part II., on Method, traverses the ground usually covered in the treatment of this subject. After a chapter on 'Class Teaching,' come those dealing with the common school subjects of instruction, including geography, grammar, and history. There is not much originality displayed, and probably the book is none the worse a guide for that. The recognised modes of teaching are clearly stated, various methods for the same subject discussed, and the whole supplemented and strengthened by the results of the writer's own experience and practice as a teacher.

Part III. gives information on the investment of savings, building societies, and sanitary matters. A knowledge of these matters is valuable, and is much less widely diffused than it should be. Its direct bearing on thrift and on health gives it special value as subjects of school instruction, and such an account as is here given of the first and second named, is not commonly accessible. This may be held to justify its insertion in a work on school management, in which we ordinarily expect to find rather the method of teaching a given subject, than a treatise upon it.

Part IV. furnishes exemplar answers to questions, or indicates to what part of the book to look for the matter of these. More than one hundred and fifty questions are thus dealt with, taken from Government examination papers on all the subjects.

Concerning the style in which the book is written less that is satisfactory can be said than of the matter. The confused mixture of the second and third person in the same paragraph, or even in the same sentence, pronouns jumbled together, and referring to antecedent nouns or clauses so distant as to be puzzling, or even to no clearly traceable antecedent, inaccurate use of words, and other errors of style abound. What else can be said of sentences and phrases like those which follow?—

'This stimulates the children much, as none like to be left behind, if possible.' 'This is the duty of the time-table.' 'It is no use to provide a change of position for any class on the time-table, without the room admits of it.' 'The teacher must . . . . see . . . . that the children have assimilated and digested the instruction' [a sequence of processes about as likely as that of food being swallowed and chewed!]. 'The teacher should call for slates, and examine them, telling them who are right, etc.' 'He must also show them that it is a part of social duty to be neat in their dress, boots laced up, and clean.' 'In teaching problems the scholars should commence with very easy ones, that they can work mentally, and make them give a reason for every operation they perform,' etc.

'Do not, by appearing to countenance something one day, punish the doers on another for the same action. If you disapprove of it, let it be shown at first. Whatever few laws and regulations you have laid down for the government of your school should be rigidly adhered to. It must be like the happy remark of Mr. Spencer,' etc.

Does the punishment referred to in the first sentence of the last paragraph consist in 'appearing to countenance something' . . . . ? What is the 'it' which 'must be like the happy remark'? Is it the 'it' of which 'you disapprove'? or is 'it' the 'laws and regulations'? How, in either case, can it be 'like a remark'? It is greatly to be regretted that a book containing so much that is good and sensible should be so faulty in style. That it should be so written by a teacher is marvellous.

Among minor faults are a disfigurement of the book by the many footnotes directing attention to 'advertisements at the end,' and the verbal errors which have been overlooked. A curious example of the latter occurs on p. 61: 'Nothing tends to destroy the confidence placed in a teacher more than *impartiality*' (!).

The Child's Bible Expositor. By S. E. Scholes. Manchester: John Heywood.

We suspect that this is a somewhat ancient book, refurbished as regards binding, but in no way altered in its old-fashioned interior. It reminds us of the sarcastic observations in the Report of Lord Sherbrook's Commission on Education in 1862, about how children in the old-time denominational schools were often far better instructed about the journeys of the Israelites and the structure of the tabernacle than they were about matters of the present day. This little book is a paraphrase of the Bible, chiefly of Old Testament history, put in the form of question and answer. Not a detail is omitted here. For instance, we have solemnly given, for learning by rote, we presume, such paragraphs as the following:—"Adoni-Zedek, king of Jerusalem; Hoham, king of Hebron; Piram, king of Jarmuth; Japhia, king of Lachish; and Debir, king of Eglon." We doubt if there could be found anywhere, now-a-days, even amongst the most old-fashioned Diocesan Inspectors, one who would ask for memory-work such as would be involved in learning bits of information like the above. Sometimes, the questions and answers here read very quaintly. 'Of what sin was Solomon guilty?' 'Having too many wives—a thousand altogether.' 'Was not this inconsistent on Saul's part?' 'Yes...but now anxiety and fear evercame every other consideration.' 'What is meant by "darling"?' 'My precious life!' Original information, such as the last, is occasionally given, but not always accurately. Thus, we find—'What is the palsy?' 'A disease *by which the nerves are contracted!*' Again, we have 'the miracle of the sun standing still' unjustifiably corrected into 'the earth to cease from her diurnal motion.' On the whole, we can regard this book as doing but little else than enabling us to realise how far education has advanced. So immeasurably have school books improved of late years, that a high standard of criticism has now to be applied to them; and few books prepared in the era before the establishment of national education stimulated authors of repute and ability to work in this field, are found able to rise up to the present standard. We fear this 'Expositor' would not now be of much service either to teachers or scholars.

The Stocking-Knitter's Manual. By Mrs. George Cupples. Edinburgh: Johnstone, Hunter and Co.

This useful little manual hardly calls for review; the fact that its sale has reached the 110th thousand is a sufficient testimony to its merits. We will not say that any one could learn to knit from its pages, for the mere making of the stitches is not attempted to be taught, and, indeed, is hardly teachable by words alone: but any person who can do the simple plain and purl stitches may learn from this little book how to turn such ordinary knitting into socks and stockings of every variety of size, shape, and pattern. Besides concise and clear directions for such small mysteries as turning the heel, working the toe, and so on, we find several patterns illustrated by engravings, for knitting openwork stockings. Cotton stockings are comparatively seldom knitted; they certainly take a long time to do, but their comfort and durability are beyond all praise, in comparison with woven ones. If knitted according to some of these pretty openwork patterns of Mrs. Cupples', stockings made of tolerably coarse cotton would be suitable for the warmest weather. We consider knitting one of the most useful parts of the needlework taught in our schools. Most garments can be machine-made to wear as long and as comfortably as though hand-made. But stockings both wear better and fit nicer when knitted than when made by any machine yet invented. Moreover, the work-woman can read, talk, or walk if she wishes, while knitting; the constraint of it is thus much less than that of any other kind of needlework, and busy wives and mothers can fill in odds and ends of time with it. Mistresses of elementary schools may thus begrudge the hours they spend in teaching this useful and pleasant avocation less than they may do those expended on

teaching *fine* back-stitching, Swiss darning, marking, and the other varieties of needlework that they know workingmen's children neither ought to nor will make real use of in after-life. Mistresses having to deal with large classes of girls who already know how to knit, but are not very sure of the number of stitches required to form the different sizes of stockings, the places for the intakes, and the methods of forming the heel, will find that they are spared much trouble by having recourse to Mrs. Cupples' practical and useful little manual, in which every such detail is fully set forth.

Two Saxon Maidens. By Eliza Kerr. (Illustrated.) London: Wesleyan Methodist Sunday School Union.

Miss Kerr has very considerable powers of narration and imagination, but we cannot but think it unfortunate that she should have employed them upon so unpromising and difficult a subject as a story of Saxon days. The first of the two maidens referred to in the title lived in the eighth century, contemporary with the Venerable Bede. She has a very objectionable relative, who is, of course, a Pagan, and who seems to amuse himself by doing everything that he can devise to frighten the poor little maiden. He imitates a were-wolf, for no other object than gratuitously to scare her nearly out of her wits; and when he is interrupted in the forest in the course of this performance by the arrival on the scene of the Venerable Bede, who carries the child to his monastery for restoration, the heartless Pagan avenges himself on the good monk by stealing his translation of St. John's Gospel. There is a good brother of this villain, who recovers and restores the MS. If the idea was to represent the good influences of Christianity as opposed to Paganism, it is not well carried out; for both the brothers are Pagans till near the end of the story, and yet one is vicious, the other moral and pious, to the same extent all through. The good brother becomes a Christian, but this does not prevent him from saying in the most unchristianlike way to his dying Pagan brother—'If you do not die, I will slay you with my own hand, to rid the earth of such a monster!' The maiden 'murmured feebly' that such language was unbefitting a Christian; and Affa said he was sorry for using it, at the moment that his fainting brother, the monster, proved the threat superfluous by dying.

The second story is both longer and more complicated. It is laid in the time of Alfred, and Danes pervade the scene, which is bathed in blood on nearly every page. No doubt, there was a good deal of fighting in those times: but people did not live always in the midst of killing and slaying. Wherever men have subsisted, they must have spent far more time in cultivating their land, in tending their flocks, in guarding against the ravages of the wild beasts, in domestic avocations, in fishing the streams, and the like, than in shedding each other's blood; but in this book, battle and rapine are the constant theme; and we cannot think it an improving one. They are very lady-like fights, too, without even the merit of being stirring and realistic. Twice in the book, at least, a Dane who has been lying for dead, turns out to have been 'playing 'possum,' and rises and glides away so suddenly that his astounded enemies 'have no time to stop him;' this is a specimen of the realism of Miss Kerr's endless battles.

Extraordinary powers of imagination and profound study are both required to make an historical novel successful; and Miss Kerr has not here given proof of possessing either qualification. Nevertheless, she displays so many good qualities as to assure us how much better she can do if she will write of what she sees before her eyes. The style is easy and flowing; many of the descriptive passages are written with a keen sense of beauty and great power of expression; and the characters have vitality and interest. What is wanting is a *story*, and suitable *detail* in the telling of it.

The Good-Natured Man: a Comedy. Goldsmith. London: Blackie & Son, Old Bailey.

This comedy has been prepared for use in elementary schools, and a life of Goldsmith and full notes to the play have been added by H. Littledale, B.A. Where a play is selected as one of the reading books for the higher standards, this will be found easier to prepare than one of the longer and more difficult plays of Shakespeare.

Home-Lesson Books: Blackie's Historical Readers I. and II. London: Blackie & Son, Old Bailey.

Every available aid in preparing for the annual inspection is eagerly sought. With three reading books to prepare in each of the higher standards, much of the matter naturally escapes the memory, and 'refreshers' are continually needed. These little books will serve the purpose very well. They contain lists of the difficult words in each lesson, with meanings to the most uncommon, and a well-written summary of the narrative of each chapter. At the end of each book is a table of the chief events and dates comprised in the period embraced in the book. They can be cordially recommended.

Appropriate and Varied Occupations for Infants. By J. E. Singleton. London: Jarrold and Sons.

This book, as its title implies, is prepared for the help of teachers in providing 'Appropriate and Varied Occupations' for the scholars of Infant Schools, as required by the Code of 1882, Art. 106 (*b*) 3.

The requirement thus phrased awakened some anxiety, and gave rise to much discussion on its appearance in the New Code of 1882. To some it conveyed the idea of Kinder-garten exercises only; to others little more than the 'Physical Exercises' of former days, accompanied by singing—now known as 'Action Songs', with marching and playground exercises.

Between these extremes, and uniting both, there is room for much play of ingenuity and tact on the teacher's part, in devising and carrying out a scheme of exercises which shall at once fit in with the necessities of child life and the educational requirements and opportunities of the school. Such a scheme is here provided. It presents a series of occupations, very varied, for the most part highly 'appropriate,' which, if neither 'complete' nor 'exhaustive,' as modestly disclaimed in the preface, is yet admirably suggestive, and in the hands of a true teacher can hardly fail in thorough effectiveness.

The book is divided into two parts. Part I. comprises Occupations proper, Singing, Drill, and Technical Employments of the simplest kind. 'The object is to institute regular organised educational play by simple means.' This excellent purpose is carried out by utilising a child's natural propensities as shown where opportunity is given, in the construction of pebble heaps, sand houses, and the manufacture of mud pies, etc., and by developing its ideas of form, recognised by the rude drawings of houses, animals, trees, and other objects which children so much delight in attempting.

Singing is dismissed with the simple recommendation of Action Songs, now so largely provided for Infant Schools.

Drill is elaborated by a careful detail of various bodily movements, many of which are common in good Infant Schools, here symmetrically arranged and prettily illustrated by outline drawings of children in the various exercises.

Much more attention is given to 'Technical Employments.' This is a highly valuable feature of the book. Much ingenuity and good sense are shown in ball-frame occupations, sticklaying, domino arrangements, drawing, pricking, 'pegging'—another name it seems for the Kinder-garten 'pea-work'—brick-building, modelling, paper-work, string manipulation, and other varieties of interesting and useful occupations. Kinder-garten

exercises of various sorts are well employed, without a slavish adherence to the ordinary book instruction on this subject.

The active ingenuity of the author is perhaps unduly exercised in the 'construction of figures' with balls on the frame, which are not free from confusion to the eye of adults, and which would be puzzling to most infants. They would be certainly difficult, if not impracticable of formation by them, and of small value when done. But with few exceptions the exercises are thoroughly good. How to use the different materials, what to aim at, and the practical application of all to other school purposes, as reading, writing, arithmetic, etc., or the common purposes of life, are well shown.

Part II. is designed to provide 'Conversational Lessons, with suggestive appropriate and varied occupations associated therewith.' There are *one hundred* such lessons, the subjects well selected, on Objects, Common Phenomena of Nature, and Natural History. Each lesson has a number of 'associated occupations' supposed to have some natural connection with it, or to be suggested by it. Thus, with the lesson on Coins are associated the occupations of modelling, drill, paper designing of various sorts, exercises on number, with ball-frame and dominoes, stick and strip laying, sundry games, drawing and pegging. And so, in greater or less variety of employment, of all the lessons.

A point suggests itself as to how these various occupations are to be combined with the lesson. No mention is made of the difficulty of preventing undue distraction of attention through the introduction of the exercises, nor is it definitely stated whether all the scholars are to be employed in them at intervals during the progress of the lesson, though such would seem to be the intention; if so, it would be interesting to know how the materials are to be distributed and dealt with; whether one occupation only is to be used at the time of giving the lesson; and whether the lesson is to be repeated and revised each time an associated occupation is engaged in, and so forth. There seems some risk of spoiling two good things in the attempt to combine them. In the very frequent case of large classes the handling of so many different things must be fraught with risk to any but skilful teachers. And no sufficient indication is given as to how these and similar difficulties are to be met.

Yet the methods indicated in the earlier part of this book and the ideas pervading it throughout are highly suggestive, and the whole forms a valuable contribution to the large number of recent books put forth for the guidance of teachers in this department of Infant School work.

Physiography: Johnston's Standard Series of Illustrations. Sheets I. and II. London: A. Johnston.

We feel we are doing the teaching profession a good turn in recommending to their notice these two capital wall-sheets. They are vigorously designed and coloured, and will form most valuable auxiliaries in impressing the main facts of physiography on the minds of youthful learners. Sheet No. I. deals with coal, coal mines, volcanoes, and geysers, and the illustrations which have been selected as representative of these subjects are well calculated to awaken and sustain the interest of the class. Sheet No. II. is devoted to Physical Geography, and treats of the subjects therein comprised in an equally happy manner. The two sheets, taken in conjunction with the explanatory keys issued with them, will afford to teachers the subject-matter of a series of lessons as full of instruction and worth as they are of interest.

*** *Several Reviews are unavoidably held over*

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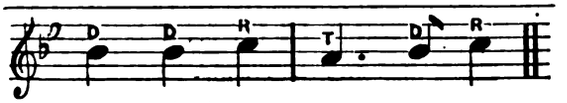
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Towards the close of the year 1860 I had an attack of low, nervous fever, by which I was greatly prostrated, and which made manifest a weakness existing in the spine. From the fever I recovered, though my physician said he feared there might have been something latent, but he hoped such was not the case.

However, early in the following year I began to suffer each morning from a high state of feverishness, which lasted many hours, and consumed my strength; upon movement my breath also became very short—and so short and rapid did it become that I can only describe the state of respiration to have been loud and hurried, the great rapidity causing the noise to be heard at a distance. Only as I remained perfectly free from movement did the above distressing effect subside, while a simple remove from my chair would at once beget the same unnatural action of every nerve and muscle. You will not wonder when I add I lost strength daily. Under these circumstances, the object, of course, of my physician was to subdue this singular state of respiration.

To attain this end I was constantly taking medicine and a variety of tonics, all of which only increased the fever, and rendered the breathing worse.

During the same year (1861) I saw several eminent London physicians, but they, with my own, were evidently quite in the dark as to the exact nature of the case. I derived no benefit whatever from their treatment; they could only say that it was not a lung affection, but one of the diaphragm.

Under the advice of my own physician I took a vapour bath, which injured me greatly, applied strong liniments, a blister and plasters, and, lastly, leeches to the top of my spine. The bleeding was not to continue for more than one hour; but, unfortunately, it was not foreseen that the very thing it was hoped it would remove was the means of preventing it from staying, and it was a day and a half before it quite ceased.

Very shortly after this I was quite laid aside, and could not move without help; constant retchings also commenced at this time. So I continued, alternately better and worse, when latterly I saw two homœopathic doctors, who said I had been both wrongly and roughly treated, and they believed it to be a case of Spinal Concussion and Irritation, and such cases, they need not tell me, were most intractable. I was not treated by either of the above, the one becoming afflicted, and the other not having confidence to make an attempt, again and again assuring my friends my case was hopeless.

But as results have since shown, my affliction, though a dark clou had yet a silver lining, to be discovered in due time.

In November last I heard of a remarkable cure by means of Electrici —a spinal and nervous case—the patient having been confined to her b for eight years. This inspired me with hope with regard to myse Soon after this your pamphlet on Magnetine was, in the providence God, brought under my notice, and its practical remarks greatly i terested me. I therefore wrote a statement of my case to you, and y very kindly replied, and advised me a Spine Band and Belt, saying mi was truly a case of spinal weakness, caused by shock to the nervous syste and overstrain by overtaxation, aggravated by wrong medical treatmei and that the before-stated condition of the respiration was an effect weakness and irritation of the spine induced by concussion of the san As in this there was no fear of my being tampered with, and as you l me to hope I might be relieved, I procured a Spine Band, and wore it directed. After some little time, and when making my usual attempt discover whether any change were effected or not, I found to my gre joy the hurried breathing subdued. However, having had so many d appointments, I thought it best not to be too sanguine, and await t next morning, when I still found no return; and with deepest gratitu do I now affirm that up to this present time no signs of all those unt ward symptoms have again made their appearance.

By degrees, and with the additional aid of the Belt, I have gradual and wonderfully progressed; from sitting up for a short time I can s up the whole day, and have done so for five weeks. I was able to wa alone very soon after wearing the Belt, and can walk slowly and gent up and downstairs. I have also taken a drive without any ill result which was a great test, considering the distress and suffering whic arose on two, and the only occasions during eleven years, when I w compelled to make a change of residence, and therefore be removed.

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To F. W. Darlow, Esq.

POSTSCRIPT.—It is a pleasure to me to be able to add, my health h been maintained up to the present time, and I can go about like tho who have not been laid aside like myself.—*E. M. JONES.* July 1st, 187

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Chairman of the Council of the Sanitary Institute.

FOOD—(*Continued*).

KEEPING the foregoing facts in mind, we get a basis for classification. The value of a food depends upon the quantity of those elements which are most easily utilised. Nitrogenous food is distinguished from all others by a portion of the nitrogen passing away in the urine as urea. It is probable that urea is the portion of the albuminous principle which is incapable of utilisation. Its chemical formula is $C_2H_4N_2O_2$. It is easily resolved into carbonate of ammonia and water. When urea is separated from the remaining constituents of albumen, there is a surplus of C and H, which represents the latent force of a given nitrogenised food. It is found by experiment that 100 parts of albumen require 150 parts of oxygen to enable it to be properly oxidised. Dr. Pavy (in his 'Food and Dietetics') gives a useful table as to the comparative value of certain representatives in the group.

Assuming that 100 parts of albumen require 150 of oxygen for perfect oxidation, he shows that grape sugar only requires 106, starch 120; but that fat demands 293. Albumen is therefore about half-way between sugar and fat, and it is in these proportions that each is capable of developing heat when properly digested by the human body. The chief duty of nitrogenous food is to repair tissue. It assists the digestion of hydro-carbons and carbo-hydrates. The labour value of such a food is thought to be by some the amount of nitrogen contained in it. It tends also to produce fierceness and savage habits; a diet limited to hydro-carbons makes people, as well as animals, comparatively mild and tractable. This, as regards the latter, is well exemplified in the case of bears. The vegetable-feeders are easily tamed, but no one can tame the Polar bear, which feeds exclusively on flesh. It is found by experience that animal-feeders among men are best able to do that muscular work which requires the continuous exercise of great strength. The power is, however, intimately associated with the quantity of carbonic acid expelled from the lungs, and not the quantity of urea excreted by the kidneys. But this latter is associated with the quantity of nitrogen in the food. Work can be done for some time without nitrogenous food, but it cannot be done for long if carbon be withheld.

Fats, or Hydro-carbons.—Fats are more powerful heat-producing agents than the carbo-hydrates, such as sugar. An average fat contains: Carbon, 79; hydrogen, 11; oxygen, 10 parts—in 100. The chemical formula has been given as $C_{10}H_{18}O$. The oxygen is not sufficient to satisfy the hydrogen. Ten grains of fat are sufficient when properly burnt to raise 23·32 lbs. of water 1 degree F., which equals 18,003 pounds of water raised one foot high. This brings it into comparison with Joule's foot-pound. Mr. Joule found that the amount of energy under the form of heat which raised water 1 degree when put into the form of force raised 772 lbs. 1 foot high. The dynamic equivalent of a thermal unit is said to be 772 foot-pounds.

It is found by experience that fat food is preferred in cold countries. There are three fat compounds—stearine, margarine, and oleine. Stearine is the most solid fat; it melts at about 145° F.; it is never found in vegetables. Oleine is always fluid at ordinary temperatures, and occurs in both animals and vegetables. Margarine is intermediate between the two, and found in both kingdoms. Fat assists digestion, assimilation, and nutrition, and it also performs some highly-important functions in the production of nerve force, for it exists in large quantity in the nerve tubes as well as in the nerve cells. It also fills up empty spaces, equalises pressure, and gives beauty of form to the body; and being a bad conductor, it enables it to retain animal warmth. It is said by some physiologists that whilst nitrogenous matter assists to make up the body and forms the acting instrument, it is the oxidation of non-nitrogenous matter which supplies the motive power, and that fat is the most sustaining kind of food, though one is scarcely able to live upon it alone for any time.

Starches, Sugars, Carbo-hydrates, etc.—In these compounds the H and O exist in proper proportions to form water, but it is not intended to imply that they are actually combined as water in the substance itself. The group consists of *starch, cane* and *grape sugar, sugar of milk, muscle sugar* (inosite), *amyloid substance, gum, dextrine, cellulose, woody fibre*, etc. Starch is the basis of all farinaceous foods. In the digestive organs it is changed first into dextrine, then

into grape sugar, whilst cane sugar is itself the product of starch in the plants in which it is found.

Cane sugar is changed into the grape form in the human stomach. The formula for starch is $C_{12}H_{10}O_{10}$, whilst that of cane sugar is $C_{12}H_{11}O_{11}$, and grape sugar $C_{12}H_{12}O_{12}$. It is similar in composition to sugar-of-milk. Amyloid substance is the same, whilst gum $= C_{12}H_{11}O_{11}$. Dextrine is similar to starch, viz., $C_{12}H_{10}O_{10}$, and lignine and cellulose correspond with it. Lignine, though corresponding in chemical composition, is utterly insoluble in the human digestive organs, and cellulose is not much better. It has been already shown that sugar has only one third the value of fat, and is as two to three compared with albumen. It is doubtful whether the carbo-hydrates contribute to force-production by direct oxidation, but they do become changed into fatty or some other matters and are stored up (when not immediately wanted) for use at a future time. They are metamorphosed in the liver, which is the fountain from which fat supplies are drawn to be laid down until wanted for the purpose of the animal economy. Over-feeding tends to produce fatty liver:—a fact which is turned to account in Strasburg in the production of '*foie gras*,' which is simply a disease in the liver of the goose, produced by overfeeding the animal whilst withholding light and exercise. There used to be a great controversy among physiologists as to the possibility of the conversion of the carbo-hydrates into fat, but the inhabitants of Alsace are practically acquainted with the result of feeding geese with maize. It appears, therefore, that by some principle belonging to vitality, which at present is not fully explained, sugar changes from the lowest rank as a heat-producer to that of the highest before it can be utilised in the system.

Acids and Alcohols.—The organic acids, such as malic, citric, and tartaric acids, are found in the juices of vegetables, especially in some kinds of fruits; they are brought out by chemical changes in the starches and cellulose of the plant. Carbonic acid being absorbed, the carbon is assimilated and the oxygen liberated. As the fruit approaches maturity there is alteration of process, and starch changes into sugar, the excessive acid of unripe fruit is altered by oxidation, tannin ($C_{27}H_{22}O_{17}$) is oxidised, and the sweetness of the fruit perfected. Fruits form agreeable and refreshing kinds of food when eaten in moderate quantities. The amount of nitrogenous matter in them is low, and they do not possess much nutritive value. In cold climates they do not rank so high as in the tropical regions, where the necessity for the production of animal heat is lessened. Nature points to this when she produces abundance of fruit in the hot climates, easily sustaining life when assisted by some farinaceous food, whilst in cold regions fat and other animal foods are absolutely required; they are always present in the arctic regions, whilst the luscious fruits of the tropics are not to be found. Nitrogenous food, especially in hot climates, leads to excessive acidity of the urine, whilst fruit decreases it. The vegetable salts which fruit contain become decomposed in the system; they change into carbonates of the alkalis, and are passed away by the kidneys.

There is another tendency on the part of sugar which has had immense influence upon the human race. Sugar ($C_{12}H_{11}O_{11}$) is acted upon by various minute organisms which exist everywhere in nature. One is well known by the name of yeast (*Torula cerevisiæ*), which increases and multiplies at the expense of oxygen in the sugar, no matter whence its source. The nutrition of the fungi, to which class these organisms belong, differs from all other plants, in depending exclusively for growth upon the absorption and decomposition of organic substances with the evolution of carbonic acid. The presence of nitrogen is necessary, by which the growth of the plant is promoted, the sugar is broken up into *alcohol* C_2H_6O and CO_2. Chemically, alcohol stands between a carbo-hydrate and a fat. Liebig thought it useful as a respiratory material, and that it was a food; but more recent investigators have shown that it cannot rank in that category, although there may be circumstances under which it possibly may be oxidised and turned to account. Dr. Parke's experiments, which are too elaborate to be reproduced here, are nearly conclusive on this point, and show that its dietetic value is very limited, even if it has any existence; one thing is certain that—whilst exercise increases circulation, and the expulsion of carbonic acid from the system, and thus promotes warmth, the removal of *débris*, and the increase of appetite—alcohol also increases the circulation, but it decreases the expulsion of carbonic acid and other *débris*, leading to a lessened temperature and decreased appetite, because oxidation is diminished. The chemical alliance of alcohol with carbo-hydrates and fats seems to indicate that it must, like those articles, rank as a food: but chemistry is not a guide in this matter, for lignine or woody fibre is $C_{12}H_{10}O_{10}$, and the turpentines, tar products, coal oils, and camphors, are close to alcohol in chemical composition. We should be poorly off indeed if we had to trust to saw-dust for food. Alcohol, like arsenic, no doubt is useful as a medicine, but as a food it is useless. As a temporary help to relieve an oppressed heart, it may give time for rest to an over-worked organ by reducing the power of the capillaries, leading to engorgement of the periphery of the system, which is its toxic effect. Yet if this process be continued day by day it must cause a diminution of elasticity, and lead to an ultimate breakdown of the constitution. Alcohol should be discarded from the diet table and relegated to its proper place in the pharmacopœia of the physician and the store of the druggist. The effect of the organisms (to which allusion has been made) upon sugar, if continued, leads to the production of lactic ($C_3H_6O_3$) and acetic acids ($C_2H_4O_2$). These acids, with butyric ($C_4H_8O_3$), and a host of others, are considered by chemists as basic acids, obtained by further oxidisation of the primary alcohols, of which ordinary alcohol is but one of a series, and it is usually considered to be the oxide of its basic ethyl. Most of these alcohols are deadly poisons, and their acids are not capable of ranking as foods.

DIET TABLES.

We are now in a condition to consider what is economical and what is wasteful in a food, and to calculate the requirements of a diet table. These will vary according as to whether the table is calculated for men or women, for children or the aged, for the sick, or those who are employed in excessive work or slight manual labour. Health cannot be maintained upon a single article, but is best secured by a good combination of the proximate elements. We have a

guide in milk, which is an all-sufficient food for the young and very aged, but it is not calculated as sufficient for the waste which hard work produces. The average daily diet for men at rest has been made out by observation by many physiologists. Dr. De Chaumont gives the following figures as indicating the necessary amounts of each of the divisions.

	At Rest.	At Ordinary Work.	At Laborious Work.
Albuminates ...	2·5 ozs.	4·31 ozs.	6·5 ozs.
Fats	1·0 ,,	3·53 ,,	4·0 ,,
Carbo-hydrates	12·0 ,,	11·11 ,,	17·1 ,,
Salts	·5 ,,	1·70 ,,	1·4 ,,
	16·0 ,,	20·65 ,,	29·0 ,,

From this table will be seen that labour increases the demand for fat and the albuminates or nitrogenised elements in a much greater ratio, than that of the carbo-hydrates.

In forming a diet table, we must know the mean composition of the articles which it is proposed to use as foods; the quantity of water which is requisite for the continuance of health will be considered in its own section, and the preceding table is calculated as the necessary weight of food which is practically water free; it must be taken as containing its equal weight of water, which can scarcely be removed from it except by destruction of its substance. The quantity of food which a man requires is also to some extent regulated by his own size; a man weighing eight stone does not want as much food as one double that weight. It has been calculated that the necessary food, reckoned according to the above table, should be about $\frac{1}{100}$th part of the weight of the body for each twenty-four hours; to this must be added the sixty or eighty ounces of water which are taken daily in some form of liquid, varying of course according to size, activity, and habits of the individual, the character of the climate in which he lives, and the clothing with which he is covered. It is necessary to know the quantity of each article in the table in a given food before we can assess its value; such tables are published in various manuals: the best of the kind is to be found in Dr. Parke's 'Practical Hygiene,' edited by Dr. De Chaumont, and which gives minute directions upon all the requisite points. In a general way it may be assumed that a healthy and vigorous man will make away with upwards of two pounds of solid (dry) food per day, and that a pound and a half of bread alone will be a starvation diet leading to loss of weight as well as loss of power. Dr. E. Smith has shown us that the average diet of farm labourers in England equal 4·25 ounces of dry nitrogenous matter with 29·5 ounces of starchy matter: whilst he found that the proportion of carbon exhaled as CO_2 from the lungs ranged from six ounces at rest to thirteen ounces when occupied with laborious work. From some other experiments which have been made, it appears that the relations of nitrogenous to carbonaceous or starchy food should be as 1 to $5\frac{1}{2}$ or 6.

The dietaries of women should be about $\frac{1}{10}$th less than that of men, or even $\frac{1}{4}$th less if the former are engaged indoors and the latter out. As regards children, the dietaries of infants should consist of milk up to ten months. Women's milk is richer in sugar than cow's milk, but it is less rich in caseine. Asses' milk is nearer in quality. Up to six or seven months, no other food ought to be substituted, as infants have not the power to digest farinaceous or fibrinous substances, but after six or seven months they may be gradually introduced, though meat should not be given in the solid state until two and a half or three years of age: according to weight, a child requires per pound three times as much starchy food, and six times as much nitrogenous as an adult. At the tenth year, a child requires half as much food as a woman; and at fourteen, quite as much; whilst growing lads of sixteen will want quite as much as an active man.

The skill of the physiologist comes to the front in so associating different articles of diet that all the wants of the system shall be provided for.

It is found by both experience and scientific experiment that nine parts of fat, twenty-two of flesh-forming substances, and sixty of starch and sugar are good average proportions for an average man.

It may be fairly assumed that many more people die in this country of repletion than of starvation.

(To be continued.)

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Friedrich Fröbel.

BY HIS PUPIL, HEINRICH HOFFMAN.

X.

MOST happy indeed has that union proved to be. The lasting gratitude and deep veneration of posterity are due to this noble-minded and extraordinary woman. Amidst sorrows and trials untold, amidst the wants and discomforts of an all but primitive state of existence—discomforts which, after a life of luxury, would have been unbearable to an inferior mind—she, like her husband, raised her eye above the thorny path up to the brilliant sun that illuminated and cheered their souls. She was as devoted an enthusiast to the educational views and plans of her husband as he himself was; and the gradual unfolding of the bud to its full splendour and beauty is in no slight degree due to her gentle influence.

The long-deferred task of building, so imperative in its necessity, could now be resumed. Fickle Dame Fortune, who had been frowning on our hero from his very cradle, seemed to give up the hopeless combat with his indomitable spirit, and with the entrance of Frau Wilhelmine, she smiled on the young institution with unwonted amiability. The fame of Keilhau spread farther and farther, and it was but a natural consequence that the number of pupils steadily increased. Fröbel felt deeply that a special evidence of gratitude, something more than sentiment and words, was due to Providence, and a favourable opportunity soon presented itself. In October, all the Protestants of Germany were in grand festive array to celebrate the Tercentenary of the Reformation. Grand speeches and gaudy processions, unveiling of statues, banquetings, and popular rejoicings of all kinds everywhere prevailed.

Fröbel could not content himself with mere vociferations; he searched for some descendants of the great Reformer, and received into his new institution two boys, whom he found at Möhra, near Salzungen, tending their father's cattle. One of them became

afterwards minister at Niederreichstedt, near Freiburg, in the province of Saxony. Thus he erected a living monument to the memory of a great and good man, and evinced his gratitude to the Almighty for the invaluable treasure given to him.

It seemed, however, as if struggles and difficulties were to be the indispensable conditions of Fröbel's very existence. Building was then, as it is now, and probably has ever been since man aimed at more than could be done with his own hands, a costly luxury, and is sure to exceed precalculated estimates. The growing number of boarders necessitated increased accommodation, and disappointment as to monetary income, not a rare phenomenon in educational establishments generally, was not unknown at Keilhau.

To aid the struggling community, Christian Fröbel gave up his prosperous business at Osterode, and, with his whole family, joined the brave pioneers of spiritual liberty. An invaluable acquisition he proved to be. Welcome as was the pecuniary aid he brought, it was of far greater importance that the institution secured in him a manager, who was a practical, clear-headed man of business. This was precisely the thing most needed, for Fröbel himself, as may easily be conceived, was sadly deficient in this respect. Until his death, in 1851, Christian remained a most faithful servant to the grand ideas that originated with his beloved brother. Dr. Wichard Lange, of Hamburg, who knew him personally, says that he was 'a representative of plain, simple-minded human greatness, a hero in his devotion to the educational idea, which he fully recognised in its truth and necessity—a Cato in character.' The necessary improvements were, in his hands, ably carried out, and the young institution prospered beyond all expectation.

During the years 1821-1825, the number of pupils increased to about sixty; new buildings had to be erected, and the inner life of the institution became stronger and healthier from day to day. Under these auspicious circumstances it was but natural that Middendorf and Langethal should find it expedient to follow the example of their leader. They certainly had not to look far for that happiness, which a well-suited marriage is able to bestow. Frau Wilhelmine Fröbel had brought with her an adopted daughter, Ernestine Crispin, who won the heart of Langethal, whilst Middendorf espoused the eldest of Christian Fröbel's daughters. Ascension Day, 1826, was a time of great rejoicing and thanksgiving at Keilhau, for on that day the two nuptials were celebrated; and henceforth the three families became as one, and called themselves the United Educational Family.

It is said that a young oak, to be firmly rooted in the ground, requires a good deal of rough shaking by violent storms. The Keilhau Institution has, to this day, proved to be a powerful oak-tree, and not a little of its strength may perhaps be due to those very storms which now and then threatened to uproot it altogether. The period following the glorious resurrection of Germany, and more especially the ill-famed Carlsbad Congress (1819), were years of political misrule, that belong to the darkest and saddest pages of German history. A panic had seized the thirty-six provinces and petty princelets; a horrid phantom troubled their slumbers. To their dismay, they had just seen in the late war what a terrible strength there was in a united nation. They felt that there were far too many of them to make a firm union, and any common effort in the true interests of the people seemed all but an impossibility. Moreover, their conscience told them that they had shamefully broken faith with their subjects, had disappointed their great expectations, and wilfully flung to the winds the solemn promises which they had made in the hour of need. What, if there lurked somewhere in the minds of the more enlightened the alarming idea, that a strong Government under *one* head—that even the republican form of government—might be possible, nay, even desirable? Such a thing could never be tolerated; so, acting upon the remorseless advice of a Metternich and others, they instituted a most barbarous persecution of all who could be in the least suspected of such dangerous aspirations. Misery untold was spread among many thousands of honourable families, in all parts of Germany. The history of those days is indeed replete with deplorable evidences of the fearful crimes to which human shortsightedness may lead when egotism is at the helm!

Mean sycophants pointed even to Keilhau, as the hotbed of revolution, and the Prussian Government demanded the immediate closing of that harmless institution. Prince Günther, of Schwarzburg-Rudolstadt—all honour to his memory—refused to be dictated to by Prussia, and to condemn without proper inquiry. So he sent his 'superintendent,' Dr. Zeh, a clergyman, to thoroughly investigate the spirit and the tendencies of Fröbel's school. His report is too interesting to be withheld. It was, in effect, as follows:—

'The two days which I spent at Keilhau were to me highly pleasant, interesting, and instructive. They have for ever imbued me with a high esteem of the school, and more especially of its head-master—a man who, amidst storms and difficulties of all kinds, has held and supported it with rare perseverance, and with the purest and most disinterested energy.

'It is delightful to be hailed by a spirit so fresh, so healthy, so free, and yet so strictly regulated by order, such as reigns in this Institution, not only during the school lessons, but also in the playground.

'What, in reality, social life never or rarely exemplifies, may be found here; a family of about sixty members, all firmly united in one strong bond of mutual affection and esteem, all of whom perform, evidently with pleasure, their several duties—a family that cannot but be successful in whatever they do, because of the strong bond of mutual confidence that unites them, and because each of them works for the welfare of the whole.

'With touching veneration and heartfelt affection they all cling to their chief, and whilst the little ones of five years embrace his knees, his friends and assistants listen to his counsels with that confidence which is due to his intellect and experience, and unwearied solicitude for the whole, whilst he himself has linked his whole being with brotherly affection to his fellow-workers.

'It is evident that such a close union, nay, brotherhood, between the teachers must exercise the most beneficial influence on their work. The affection and esteem with which all the teachers cling to their head-master manifests itself in an attention and obedience, which renders disciplinary rigour all but unnecessary. During the two days I heard no rebuking word, neither in the merry gambols in the playground, nor during the lessons; and in the frolicsome bustle, with which after

schoolwork is over, all rush into the open air, gambolling about to their hearts' delight, I saw no real misbehaviour, no rude, unmannered conduct; least of all anything improper.'

(*To be continued.*)

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Lessons in English.

BY ALEXANDER BAIN, LL.D.,

Author of "Education as a Science."

IV.—The Definition of Poetry.

The distinctive characteristic of poetry, as setting forth Ideals, has been assumed, and partly illustrated, throughout the foregoing remarks, but yet deserves a more special handling with a view to the definition that we are in quest of.

Ideality is contrasted with Reality, that is, with facts as they actually occur. To idealize is to depart from the actual, so as to present a picture more acceptable to our feelings. The painter chooses a scene of nature, containing many beauties, but also some things that mar the effect; these last he omits from the picture. The most heroic man has points that either clash with his heroism, or are simply unrelated to it; a poetical narrator avoids all such.

Nothing could better confirm our general position, that the end of poetry is to please, than this habit of altering reality to conform to an ideal. If the poet's so-called "truth" were matter-of-fact truth, he would not dare to idealise, any more than a scientific geographer could venture on re-casting the plan of the Alps, to make them still more impressive and grand, or than an anatomist could teach the contour of the human body from a Greek statue.

As the highest pleasure attainable through works of Fine Art could not be reaped from literal reproduction of the outer world, the Artist is justified by the end in the choice of his means. It is almost certain that a prosaic narrative of the Trojan war would have been very flat in comparison with the Homeric story. We are better pleased with the gorgeous ideal than we should have been with the actual. Possibly there might have been a considerable degree of human interest in the literal facts, but these would not have been a poem; the poetical handling saves all the interest, purges it of its dross, if any, and augments it, in a way that only high poetic genius can accomplish.

In gratifying the powerful feelings of the mind, by setting forth their objects in idea, which is all a poet can do,—much is obtained by proper selection and omission; much by illustration, adornment, and happy turns of thought; much also by *exaggeration*. It concerns the critical art to assign the due limits of this exaggeration, under all variety of circumstances. In some cases, it is not productive of the slightest harm; if only it succeeds poetically, we can easily overlook the departures from literal truth. In the tales of Fairy Land, and the extravagant fictions of middle age Romance, nobody is deceived; we treat them as efforts of imagination, and judge them accordingly. When, however, the subjects of Poetry are historical, we demur to an excessive falsification of the facts. The demand for truth is still greater, when the subject, historical or not, is meant to embody a practical lesson, whether of morality or of prudential virtue. That high ideals of duty should be presented, we allow and commend; mankind never err on that side. The mischief of exaggeration is chiefly seen in over-stimulating our expectations, and in the indulgence of our amiable weaknesses. The best illustration is furnished by the treatment of the love passion.

It may be said that every poet has sung of love. Here is a source of natural interest to start from: the subject is peculiarly fitted for the arts of the singer; and is in itself an inspiration. But do poets abide by a truthful handling? do they keep within the bounds of sobriety in stating the power and fruition of love? Not always.

Poetry does a great work in evoking the charm of the human affections, and thus extending the sphere of their interest in human life. The temptation is to make up for the want of the real by over-doing the ideal pictures. Thus, to present love in all its force, the disenchanting accessories are left out, or toned down; exceptional states of elation are made the rule; the temporary is given as the permanent. In real life, great pleasures are attended with cost, and often interfere with duty; the poet disregards both circumstances. In nuptial love, there is great scope for poetical adornment; and ample justice has been done to the ideal. Whoever wishes a statement of the reality has to refer to sober observation or matter-of-fact biographies. If there be any subject that can dispense with exaggeration, it is love; the literality fairly handled is a sufficient basis of the highest artistic interest.

There being both a spiritual side in the love passion, and a gross or carnal side, poetry can throw its force into either. Dryden is blamed by Wordsworth for knowing only the second. Shakespeare gives us both. There is always a danger in spiritualizing beyond what human nature can receive, as in the saintly pictures of women, so familiar to us.

Yet poetry is a great refining influence in one most important way. Those feelings that, in their own nature, are violent and transitory, are filled out and mingled in the poetic treatment, so as to cover a large space in our minds, and so to multiply the amount of gratification. The wrath of Achilles in its literal circumstances would yield only a few passing throbs of sympathetic resentment. The Homeric treatment is a fifty-fold enlargement of the interest. The melancholy and beautiful story of Hero and Leander, in a matter-of-fact treatment, would have an undoubted interest; every one feels how much this is increased by the poetical expansion.

Other illustrations could be given of the weak points and dangers of idealising. Frequently too much is attempted—the mind failing to rise to the height of the poet's fancy: as when affection becomes maudlin; strength, turgidity; indignation, coarse ferocity.

All this, however, is to sin against the laws of poetry itself.

In Poetry and in Painting, we have what is termed the Realistic school, in opposition to the Idealism that transcends actual life; as in the contrast of the Italian and the Dutch masters in painting. A realistic treatment is not withdrawn from the principles of Art elevation: it merely makes the most of a subject with the least possible deviation from literality. A different kind of pleasure is given by this mode of treatment; and the artist has to study the laws of that pleasure, no less than the ideal composer in his own sphere.

It is by pourtraying character that the poet draws out the feelings that connect us with our kind; and the idealising process involves all the arts of omission, selection, addition, that have already more than once been noticed. A certain amount of these transfiguring operations may be essential to the charm of the picture. The laws of poetic taste, supplementing the instinctive judgment of the poet, determine how far it is safe to go.

The poet has always been permitted to flatter his own nation, and race, and all its notabilities, in the grossest way. Pindar's genius shone in this department; it was a part of his vocation. In every age the same thing is repeated. The devices of omission, selection, and disposition of circumstances, together with poetic ornament, are employed to make the most flattering ideals of national heroes and personal favourites, with the correlative depreciation of enemies.

It is considered eminently poetical to set forth the pomp and circumstance of glorious war, and to shut out of the view the hideous reality. Luckily for mankind, there is a growing revulsion to such an employment of the genius of style.

The Psalm of Life, by Longfellow, is a fine example of the moral ideal, intended not merely, nor principally, to indicate the path of duty, but to encourage, stimulate, and support us in the actual performance. This is a genuine poetical attempt, carried out by poetical means. If it is not often efficacious, the fault is less with the poet, than with human stubbornness. No doubt, he overstates his case; the struggle to do well is more arduous than he allows; but the amount of license taken has been permitted to poets and preachers in every age.

Poetic truth is a misnomer; it is a play upon words. Truth is truth only while representing the world precisely as it is, and by the help of the technical devices of science. An artist's truth is another name for taste, or propriety; in other words, attending to the arts that bring about the poetic charm.

The Ideal justifies itself most in the spheres of the supersensual and the unreal. When we have no actualities to encounter, but only ideals, the shaping of those ideals is everything. It is little use idealising upon everyday facts; thinking of a feast, when we have no food. But when sorrows are imaginary, as in the forebodings of uncertain futurity, they may yield to the power of a poet's solacement.

The Idealising process is demanded for the paramount condition of HARMONY, so essential to Art.

It is by harmonising all the circumstances of a theme, whether narrative, descriptive, moralising, or life-guiding, that we produce an artistic work. In the literality, many things jar with each other, and with the general effect; the artist must efface all discords. In real life, an aristocrat may occasionally fall below the proprieties of his type; a plebeian may rise above it; the poet and romancist would set both right. It is a kind of paradox to learn that very successful pourtrayers of class-types have had little personal contact with examples of them. George Eliot gives a public-house colloquy, true to the life, as we fancy, without having any personal experience of such scenes. Perhaps a literal report of what was said on an actual occasion would seem less truthful than her version. Knowing the characters in general life, she divined what would be most suitable to each, although not exactly corresponding to any single occurrence.

The necessities of Harmony do not imply any great amount of distortion of fact, being fulfilled by the most realistic of poets and artists. To idealise for this end is not merely commendable, it is essential to Art. A painter must group his colours, according to the laws of his art. A poet must see that his language is melodious in itself, and, in keeping with his thoughts. He may idealise much or little, but if he fails to harmonise, neither the interest of his story, nor any amount of life-criticism will make him a poet. It is a main part of minute analysis, as abundantly shown in the foregoing Lessons, to inquire into the keeping of images with the subject and with each other. In such subtle harmonies most frequently consists the poetic thrill.

It has now to be seen how far VERSE makes part of the definition of poetry. In the most characteristic form of poetical composition, verse is employed. It is an aid to the charm of poetry, and in various ways. There is a felt consistency between the march of metre and the tone of mind described as elevation or loftiness of strain. When we rise out of our calm and commonplace moods into a high pitch of emotional excitement, our carriage and mode of expressing ourselves are found to be quite different; and, to that difference, the language of metre is somehow more suitable than the language of prose. As the words that we make use of, by preference, are distinguished by strength, intensity, emphasis, so the form or rhythm is peculiar; and though we cannot declaim in verse offhand, we feel that verse is the form most appropriate to the situation. In the presence of a sublime scene of nature, if we express our feelings in words, they must be words of a high order of majesty and dignity; and, if we were able on the spot, we should impart to them a measured rhythm or metre, as most accordant with the feeling that possesses us.

Such is a statement of the fact, without attempting to assign any reasons arising out of general laws of the mind. That, when our mood is changed from a calm, ordinary pitch, to one of high or intense emotion, the manner of expressing ourselves should also change is what might be expected. Also that, on such occasions, we should choose the words that have been always in use for venting high emotions, is also quite natural. But we are without a reason for the choice of metre, except in the fact that metre has, by long usage, become also associated with a lofty emotional strain. There, however, remains the question, why metre should have been originally chosen for such occasions, and why it should be retained as intrinsically suitable to poetical feeling. True, something different from common prose is needed; nevertheless the selection of an entirely distinct vocabulary might be accepted as a sufficient change.

There are two circumstances that may be assigned as rendering metre more suitable than prose for the excitement of intense emotion. The first is that, being simpler, we fall into it more easily; we know more exactly how to graduate and adapt our emphasis in pronouncing verse, than in the uncertain accentuation of prose.

Now, it is the nature of excitement to lower our intellectual quality of discriminative selection and adaptation of our movements. In passion, we are more

energetic, but less capable of delicately adjusting our movements; hence a simple rhythm suits us better than one which is complex: the simplest measures of all, the Lyric, are connected with the greatest intensity of passion. According as we can approach a subject with more calmness, we can accommodate ourselves to greater elevation of metre, as in the reflective sonnet.

A second way that metre acts, is in controlling or regulating our passionate excitement. When we are very much roused, our movements are violent, irregular and transitory; by falling into a set march, the excitement is subdued and prolonged. Metre is like the regularity of the dance, which gives vent to the stimulus of music and society in a measured style; it is an agreeable and yet effective controlling power.

To these considerations may be added the influence on the mind of regular and recurring beats, which yield a pleasure of very extensive prevalence in the Fine Arts.

Finally, we must revert to the remark already made, that the form of verse has become indelibly associated with the diction and the elevation of poetry. So much is this the case, that, whenever we set ourselves to compose in verse, the language that comes to our mind is the language of poetry. Our recollection of words falls into totally different channels from the recollection of prose diction. Many a one can write better in poetry than in prose; their best thoughts and expressions having come to them by reading the poets. This is quite irrespective of an original predisposition to the form of verse, as seen, for example, in Pope.

Verse is not poetry without the accompaniments of a poetic vocabulary, and all the figures and arts that are accounted poetic; such as inversion, ellipsis, exclamation, and other well-known departures from prose. The putting into verse of the ordinary prose style is not poetry. It is often done in comic writing, as in Hudibras; the comic effect is obtained by the degradation of the lofty form of poetry to a vulgar use: being an indirect testimony to the intrinsic dignity of the metrical form. We have frequent instances of blank verse unintentionally becoming prosaic. This is seen, for example, in Shakespeare, who uses blank verse with unexceptionable propriety, when his subject is familiar and prosaic; in that case, however, he departs from the diction and devices of typical poetry.

Our English Literature has given birth to a species of elevated prose, which is illustrative, both by agreement and by contrast, of the connection of verse with poetry. The grand prose style of Jeremy Taylor, of Milton, and of many more recent writers, as De Quincey, or Carlyle, approaches to poetry in the elevated diction, and in some of the poetical figures, as inversion, exclamation, interrogation: but in stopping short of the form of verse, it also omits the bolder devices of poetry; such as the license in the choice of words, the sustained inversions, the free use of ellipsis, the flights of imagination, the play of fancy, the asserting of unqualified and extravagant propositions,—all which are permitted to the poet only in his full metrical garb. The pomp of language is less sustained, even in the loftiest prose, than in typical poetry. Milton alternates his grandest passages, in the prose works, with purely prosaic touches that would not be admissible in a poem.

Dignity, elevation, lofty emotion, have many degrees. As we rise ever so little above familiarity and common-place, our attitude and movements change, and with them the choice and rhythm of our speech. A speaker at a public meeting, a judge on the bench—unless when purposely humorous—assume at once an altered tone of gesture and of speech. There is a like transition from the attitude of imparting knowledge to the utterance of high emotions, as admiration, veneration, indignation; and at the greatest attainable heights in such outbursts, the form of verse, with the becoming adjuncts, will always be found suitable. The Psalms of David were first translated into prose, but did not fully satisfy the feelings of the pious worshipper until re-clothed in verse.

To illustrate the distinction by example, take first the genuinely poetical stanza of Campbell:—

> Of Nelson and the North
> Sing the glorious day's renown,
> When to battle fierce came forth
> All the might of Denmark's crown.

The metre is here simple and energetic: the diction lofty, the arrangement inverted and rhetorical: the poetic type is fully realised.

As a contrasting example of elevated prose, let us cite the following passage from De Quincey:—

> "The silence was more profound than that of midnight; and to me the silence of a summer morning is more touching than all other silence, because, the lights being broad and strong as that of noonday at other seasons of the year, it seems to differ from perfect day chiefly because man is not yet abroad; and thus, the peace of nature, and of the innocent creatures of God, seems to be secure and deep, only so long as the presence of man, and his unquiet spirit, are not there to trouble its sanctity."

There is here an approximation to poetry, yet with obvious differences. The mind feels much calmer in the perusal, and all the arts of high composition are at a much lower pitch, while yet considerably above ordinary or typical prose.

Quite distinct from the question of verse as more or less essential to poetry, is the consideration of the *language-music*. Melody may accompany verse, or it may not: it may also be realised in prose. In both cases, it is an additional merit; and especially so in poetry. But great poets are not uniformly distinguished for melody; and versification may be very perfect without it. The poet being, above all other men, required to give immediate pleasure, he must not neglect the point of being melodious: but some of the greatest poets have been too devoid of a musical ear to infuse the quality into their verse; witness Pope, Johnson, Scott, as contrasted with Milton, Gray, Coleridge, Moore, Tennyson.

There remains now only the position of the Prose Romance or Novel. Is this poetry or not? As a question of definition, it resembles cases sometimes arising in Natural History, where a species has a large majority of the characteristics of a peculiar genus, with the absence of several that are of leading importance; there being, at the same time, no other genus where the species would be more suitably mated.

Now, the prose romance has the most prominent characteristics of the Epic in verse. It is an idealised narrative, intended to touch the same emotions, and by similar arts. It marches at a lower level of intensity, and accommodates itself to our most ordinary moods, in point of emotional strain; thus endeavouring to give as much as possible of the same kind of

pleasure with less exhaustion in the end. A novel can be read in two or three sittings: an Iliad or a Paradise Lost would be too fatiguing to be so disposed of. The novel is easy, diluted, and familiar prose; but not, therefore, commonplace. Originality and strokes of genius can be made at the lower strains of feeling, as well as in the higher. The attitude is changed, but not the opportunities of being felicitous.

If we do not stretch the definition of poetry so as to include the prose romance, that peculiar form of composition is without a place in any known classification of literature. It is neither science nor oratory; it is not history in the proper sense of the word; it is not morality or theology. If we were to make it a class by itself, we should be repeating nearly all the arts of Poetry, in unfolding its characteristic aims and devices. We have only to allow for the differences due to the form of prose, and for the reasons of adopting the prose vehicle, and there remains to us the substance of poetry. The novel gives us often highly-impassioned prose, thus coming so much nearer to the typical poem, but still divided from that by the distinction between the loftiest prose and the march of verse poetically framed.

Thus, while not obliterating or explaining away the difference that verse makes in composition, we must consider the modern prose romance as a species under the genus Poetry, which must be so far widened as to include it. The form of verse is not to be held as generic and essential to all poetry, but as an important specifying mark in the widest, and perhaps highest class of poetical compositions.

In an exhaustive discussion of poetry, the various recognised species—Epic, Dramatic, Lyric, etc.—would be examined and characterised. This is not indispensable to the definition of poetry as a whole; although it would supply many good illustrations of that definition. In all these leading divisions there are cross-divisions, as, for example, the serious, and the comic, or satiric; and something could still be added by way of reconciling this last class with the definition of versified poetry. Indignant denunciation or grave satire may be quite consistent with the march of metre; but comedy would seem to be such a relaxation of the dignity of the high poetic strain, as to be destructive of the very notion that we have been trying to connect with adequately supported verse. The solution has been already hinted at, and need not be further pursued.

With the assistance of the Lessons on the Emotional Qualities of Style, the characteristics of poetry, as now expounded, will, it is hoped, be sufficiently intelligible. Nevertheless, the length of the discussion, and the numerous windings that it has taken, with occasional repetitions of the same topic from different points of view, seem to justify one more addition in the shape of a summary.

1. Poetry is to be reckoned among the Fine Arts; and possesses the attributes common to the class. These attributes are to be ascertained, in the first instance, with a view to the definition of Fine Art generally.

2. The source of such a definition is to be sought in the sphere of the human emotions; of which a certain number are properly Æsthetic, or Fine Art, Emotions. The governing circumstance is always pleasure; although often disguised by circumstances, and not unfrequently taking the shape of relief from pain: yet all pleasures, and all modes of alleviating pain are not æsthetic; and the specific marks of such as are properly so, need to be clearly ascertained.

3. The characteristic of Poetry as a species of Fine Art consists in employing Language as the medium; on which fact is suspended a numerous host of distinctive qualities. It brings poetry into close connection with all regions of knowledge; since nearly every kind of knowledge finds embodiment in speech. One consequence is the difficulty of disentangling the purely poetic effects from what belongs to the other species of communicated knowledge.

4. In such a complication, resort is had to contrasting definitions of those several departments that become entangled with poetry. As respects the *matter*, these are Science, Eloquence, Morality, Religion. As respects literary *form*, we have History, or Narrative, Description and Exposition; all which may assume both poetical and unpoetical forms. Poetry needs a subject, and, while it imparts its own form to that subject, it avails itself of any accidental advantages that the subject may intrinsically possess for aiding in the desired effect.

5. While the end of poetry can, with more or less difficulty, be distinguished from the ends of other species of verbal composition, its means can also be distinguished. The Rhetorical art provides a full examination of all the devices, verbal and other, for fulfilling the end of poetry, as such.

6. The scope of poetry is intimately combined with the three great attributes named, respectively,—Concreteness, Harmony, and Ideality—whose meanings, fully understood, go far to confine the poetical art within its legitimate boundaries. The discussion of Ideality in particular is especially instrumental for putting clearly the difference between poetic and unpoetic form.

7. The element of Verse enters into poetry in its fullest and most typical character. A modified form of the poetic species assumes the garb of prose, and though adapted to a difference of mood in the reader, has yet so much of the essence of poetry, as to be more properly included with it, than with any other class of literary compositions.

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The New Class-Subject, 'Elementary Science.'

(What to teach, and how to teach it.)

BY RICHARD BALCHIN.

IT will be unnecessary to give the subject-matter of the remaining lessons in the course for Standard III., of which the syllabus appeared in the February issue of this magazine. For all the facts are detailed with sufficient fulness in the new edition of the 'Science Reader,' No. 1. This book may now be obtained of the publisher, Mr. Joseph Hughes. To restate those facts in these articles would be a needless repetition. I therefore proceed to the consideration of the work to be done in Standard IV.

At this stage, we have reached a point at which the easy conversational style should begin to give place to a more solid and serious treatment. The *general*

should now lead to the *particular*. Hitherto, that is to say, in Standards I., II., and III., it has been my aim to arouse a *desire* to know, rather than to burden such young minds with what *is* known. The purpose of the foregoing articles has been to excite a curiosity respecting the nature of the things around us.

It appears to me that the whole course of work throughout the school, so far as this subject of elementary science is concerned, resolves itself into three stages, viz. :—

1st. To create a *desire to know*.
2nd. To explain the processes by which we *get to know*.
3rd. To teach those facts and principles that are thought to *be known*.

Stage 1 is the aim of the teaching in Standards I., II., and III. Stage 2, in Standard IV. Stage 3, in Standards V., VI., and VII.

In Standard IV., therefore, I assume that the work throughout the year will be mainly to make known those various modes of investigation by which we arrive at scientific accuracy respecting the nature and properties of the various objects and phenomena around us. Here, again, our course of investigation naturally resolves itself into three stages, namely :—

1st. We make experiments.
2nd. We accurately record the facts resulting from such experiments.
3rd. We logically deduce conclusions; we enunciate the law or principle to which our facts have led us.

Do not let any teacher be alarmed at what sounds very formidable work for such little children as we find even in Standard IV. It is well that boys, aye, and girls too, should, as soon as possible, become familiar with that scientific process, by which alone all definite knowledge of any value is obtained.

Let me give an instance to show how extremely easy it is, even in the case of quite young children, to deduce a scientific truth by a process of investigation strictly scientific and logical, though very simple. Suppose I wish to evolve the rule or law respecting the inclined plane, that 'the power is to the weight as the perpendicular height of the plane is to the length of the incline.' Here we shall use apparatus —a model—with which to make experiments. The first thing to be done, therefore, is to describe this apparatus, *i.e.*, the *length* of the plane; the methods of varying the *height* of it; the character of the *weights*, etc., used; and the contrivance for the elimination of frictions.

I suppose every teacher has read Tyndall's 'Heat, a mode of Motion.' It will be seen there that the professor is going to use the thermo-electric pile. Well, he begins, *not* by at once making experiments, but by describing the apparatus: and, by the way, how exceedingly charming is that description! How clear and logical!

Well, having explained our model of the inclined plane, we proceed to make experiments. Knowing the height and length, we find that the power, represented by a descending weight of, say two pounds, maintains a weight represented by six pounds, in equilibrium. We record this fact, *i.e.*, write it on the blackboard. Vary the weights, and again record the result. Now change the height of the plane and get more facts. Having now obtained six or eight separate results of experiments and written them down accurately, draw the board round to the front of the class, and talk about them; reason about them; see if there is any general law or truth to which they point; if there is, let it be distinctly stated.

Now, I maintain there is nothing whatever in all this too difficult for ordinary Fourth Standard children. And if we accustom boys to this method of investigation, are we not adopting the only sure way of training the mind in 'habits of exact observation, statement, and reasoning,' as the Code of 1883 so well describes it?

As in the case of Standard III., I may state that the scheme of lessons for Standard IV. is based upon the contents of the 'Science Reader' for Standard IV., published by the editor of this magazine and written by myself. The following is the syllabus, with the number of lessons forming the year's course. The chapters are the contents of the book, and full-stops separate the various lessons.

CHAPTER I.

Matter, and elementary bodies. (One lesson.)

CHAPTER II.

The most common elementary bodies: Oxygen. Carbon. (Two lessons.)

CHAPTER III.

Hydrogen. Nitrogen. Composition of water. Composition of air. (Four lessons.)

CHAPTER IV.

Distinction between chemical and physical properties. Weight. Attraction of cohesion and the three states of matter. Indestructibility of matter. (Four lessons.)

CHAPTER V.

The mineral kingdom: rocks, minerals, and metals. Granite, clay, slate, and sandstone. (Two lessons.)

CHAPTER VI.

Limestones: different kinds; how formed. (One lesson.)

CHAPTER VII.

Metals: chief ores. The scientific principles involved in the smelting of iron. (Two lessons.)

CHAPTER VIII.

Force, work, and machines. The simple machines or mechanical powers. (Two lessons.)

CHAPTER IX.

The air: its physical properties, weight, and temperature. Thermometer. Barometer. (Three lessons.)

CHAPTER X.

The aqueous vapour in the air. (One lesson.)

CHAPTER XI.

Dew, clouds, and rain. Hail and snow. (Two lessons.)

CHAPTER XII.

The vegetable kingdom: parts of a flowering plant: root, stem, leaves. (One lesson.)

CHAPTER XIII.

Parts of a plant (continued): the flower; Wall-flower. Buttercup. Primrose. (Three lessons.)

CHAPTER XIV.

Products of a plant: distinction between organic and inorganic matter. Starch. Sugar. Oil (*i.e.*, vegetable). Gluten. (Five lessons.)

CHAPTER XV.

The animal kingdom: vertebrata and invertebrata. The five classes of vertebrata. Class V. Fishes. (Three lessons.)

CHAPTER XVI.

Amphibians (2). Reptiles. (Three lessons.)

CHAPTER XVII.

Birds (2). Mammals, insectivorous. Herbivorous. Carnivorous. (Five lessons.)

In the above course there are forty-four lessons. There are, however, several supplementary lessons that it will be necessary to give. For instance, a description of some of the apparatus used, such as the pneumatic trough (two lessons); the structure of flame (one lesson); the Bunsen burner (one lesson); a common spirit lamp (two lessons). In the early part of the course it will also be found necessary to give lessons upon such operations as evaporation, condensation, distillation, filtration, and precipitation.

(*To be continued.*)

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Article 106 (*b*)

Merit Grant in Infant Schools.

BY MRS. MORTIMER,

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LESSON—FOOD.

CLASS—CHILDREN OVER SIX.

I. *Introduction.*—What do you call the first meal you have in the morning? Breakfast.

What do we have for breakfast? Bread-and-butter, tea, coffee, milk, and sometimes fish, eggs, or bacon.

When do you next have anything to eat? At dinner time. What do you have for your dinner? Meat, potatoes, cabbage, and sometimes peas or beans. Do you have another meal during the day? Yes, we have tea. What do you have for your tea? Bread-and-butter, and sometimes marmalade or jam. Is that all? do you not drink anything? Oh, yes; we have tea, or hot milk, or cocoa.

Now tell me the different times during the day that you have meals. Breakfast, dinner, and tea time. How many times is that? Three. Is there not another meal? Yes, father and mother and grown-up people have supper. When do they have supper? At night when we are in bed.

Can you give me one name for all the different things you have for breakfast, dinner, and tea? Yes, they are called food. What do we do with the food? We eat it. Do we eat tea, coffee, cocoa, and milk? No, we drink those things. Tell me the names of some food we eat? Bread, meat, potatoes, cheese, cabbage. Now tell me the names of some we drink. Tea, coffee, cocoa, milk, water.

II. *Uses.*—How do you feel if you have not had any food for a long time? Very '*hungry*.' And how do you feel if you want something to drink? Very '*thirsty*.' Do you know why we eat and drink? Because we are hungry and thirsty. What does the food do for us? It makes us grow big and strong and keeps us from being ill. What would happen to us if we were not to have any food? We should be ill and die. Then you see food keeps us alive and makes us grow strong.

III. *Different kinds.*—Now I want you to think of all the different things we eat, and see if we can find out where they come from. First think of your dinner, what do you generally have? Meat and potatoes. Where does your mother get the meat? She buys it of the butcher. Tell me some different kinds of meat? Mutton, beef, pork, veal. What else do you have,—think of Christmas? Ducks, goose, turkey, fowl.

What do we call mutton? The flesh of the sheep. What is done to the sheep before the flesh is called mutton? It is killed. What is beef? What is pork? Yes, but the flesh of the pig is also called bacon. I will tell you the difference between pork and bacon. When the pig is killed the flesh is called pork. A great deal of this pork is salted and smoked by means of wood fires, and then it is called bacon. And what is veal? The flesh of calves. What are calves?

Can you give me one name for bullock, sheep, pig, duck, goose, turkey, fowl? Yes, they are all animals. Then you see all our meat is obtained from animals, and therefore we call it *animal food*. But there are also some other animals that we eat. Cannot you think of any? I am thinking of fish. Now tell me the name of some? Cod, herring, haddock, eels, and plaice. One little boy said bloaters. Well, you must remember they are dried herrings. Now name all the animal foods you know, and we will write the names on the blackboard.

What do you have for your dinner besides meat? Potatoes and cabbage. Try to think of something else. Beans, peas, turnips, carrots. Do you know what we call these things? Well, look at the word I am writing on the board, veg-e-ta-bles. Now what do we call them? Vegetables. How many kinds of food do you know? Two. What are they? Animal food and vegetable food. We will now write down all the vegetable foods you can think of. You said you had bread and milk for breakfast. From where does the bread come? From the baker. Do you know of what the baker makes the bread and from where the flour is obtained? Then under which kind of food shall we put the bread?

From where do we get the milk? From the cow. Then in which line shall we put milk? Then you eat butter. Who can tell me where we get butter? Of what is it made? Then where must we put butter? One little boy said he had an egg. Where do you get eggs? In which line shall we put eggs? In a similar manner the teacher should deal with the other things mentioned by the children.

IV. *Summary.*—This would consist of the two columns of names containing (*a*) animal food; (*b*) vegetable food.

The children then for an exercise should divide on their slates each class of food into (*a*) food for eating, (*b*) food for drinking.

Another exercise might be to require the children to point out the foods used at the different meals.

LESSON—THE ORANGE AND THE LEMON.

CLASS—CHILDREN OVER SIX.

Apparatus:—An orange and lemon. A picture of the trees.

The children should be asked to name these fruits, and then their attention should be directed to the orange.

I. *Description.*—What can you tell me about this orange? It is round. What colour is it? Of a reddish yellow colour. This kind of yellow we call orange colour. It is

also bright. If you feel it, what would you say? It is smooth, and rather soft.

Before you eat an orange, what do you have to do? Take off the outside. What is the outside called? The peel. Who can peel this orange? Do you peel it like you do an apple? No, you can pull the peel off the orange. And the apple? You must cut the peel off. Now let me look at the peel. What colour is inside? It is white. Yes; now look at the edge of the peel, and tell me whether the yellow or white part is the thicker? The white part. Yes; the yellow part is very thin. How does the yellow part taste? Very bitter. Do you eat the peel? No; it is not nice. Which part of the orange do you eat? The inside. Well, we will now look at the inside. What colour is it? Yellow. What covers the inside? A very thin skin; here is a piece of it, it is so thin that you can see through it. Now watch me; what am I doing? Breaking the orange into pieces. What do you notice about each piece? It has a thin skin all over it. Let us count how many of these pieces there are. How many? Ten. Sometimes there are nine, and sometimes eleven. Look at one of these pieces; what shape is it? It is half a circle. Yes; the outside of the half circle is very thick, and then it gradually gets thinner. Anything of this shape is said to be wedge-shaped. We will now break this skin, and then what do you see? Juice, pips, and the pulp. Which do you eat? The juice and the pulp. What do you do with the pips? Throw them away. Now look at the pulp; what can you say about it? It is yellow, very soft, and made up of a great number of little pieces; if you taste it, it is sweet. Are all oranges sweet? No; some are very sour. I suppose you do not like them, then?

II. *Uses.*—For what do we use oranges? For eating. Do we eat them for our dinner or tea? Oh no; we like to eat them at any time. When do you like an orange? When we are thirsty. Why? Because it is so juicy that it quenches our thirst. There is another use we make of oranges; do you know what it is? They are made into marmalade. What do we do with marmalade? Put it on our bread and eat it; it is something like jam. Then I daresay when you are eating cake you sometimes find some pieces of peel. The peel of the orange is used for this purpose after it has been preserved with sugar. This peel is also put in puddings.

III. *Where found.*—Do you know where we get oranges? They grow on a tree called the orange-tree. We do not see orange-trees growing in this country, for it is not warm enough to make the fruit nice; they grow in very warm countries. Do you know how we get them here? They are picked off the trees and packed very carefully in boxes, and then they are brought to England in ships. Who has seen one of these boxes of oranges? What have the oranges round them? They are wrapped in soft white paper. Do you know why this is done? To keep the oranges from rubbing and knocking against each other. What would happen if they did knock against each other? They would be bruised, and then they would go bad.

We will now talk about the lemon.

I. *Description.*—What can you tell me about it? Is it the same shape as the orange? No, it is not so round. Tell me something that is of the same shape. An egg. What do we say of things that are of this shape? That they are oval. Now, all of you repeat, 'The lemon is of an oval shape.' What about the colour of the lemon? It is lighter than the orange. Yes; we say the lemon is of a pale yellow colour; it is smooth and rather soft like an orange.

What part is this? The peel or rind. You see I can take the rind off just in the same way as I did the orange. Now look at the peel; what will you say? It is made up just like the orange, yellow outside, and a thick white part inside. Yes; and you must be very careful not to eat the white of the orange and lemon, for it is likely to make you ill. Now look at this part, and you will see that it is covered by a thin skin, just like the orange, and yet when you look at the inside of the lemon you can see a great difference. What is the difference? It is very pale in colour. How else does it resemble the orange? You are able to divide it up into a number of small pieces. Yes; count the pieces and tell me how many there are. Now look at one of the little pieces and tell me what you notice. We see that there are pips, pulp, and juice, just like the orange. Taste one of the pieces; does it taste like the orange? Oh no, it is very sour.

II. *Uses.*—For what do we use lemons? To make lemonade. For what do you use lemonade? For drinking. Why do you not eat lemons as you do oranges? Because they are so sour; we make a drink of them instead, and we put a great deal of sugar with them. For what else do we use lemons? They are sometimes made into marmalade, and they are used to flavour pies, cakes, etc. Lemon peel is also used like orange peel, to put into cakes, puddings, etc.

III. *Where found.*—Lemons grow on trees in warm countries, like the oranges, and they are sent to this country much in the same way. Lemons are wrapped in paper and packed carefully in boxes.

IV. *Summary.*—The orange and lemon have a peel; they are divided into parts. Each part contains pulp, pips, and juice.

They grow on trees in very warm countries.

The peel of the orange and lemon is used for flavouring.

The orange and lemon are made into marmalade.

The orange is round and the lemon is oval.

The orange is sweet and the lemon is very sour.

The orange is used for eating, and the lemon is made into lemonade.

This summary would have to be written on the blackboard at the end of the lesson, so as to make a comparison between the two fruits. It should be obtained from the children, and would thus serve as a recapitulatory exercise.

LESSON—THE OYSTER.

CLASS—CHILDREN OVER SIX.

Apparatus:—Oyster, a few shells, an oyster-knife.

I. *Description.*—The children should be shown an oyster, and asked to name it. What part of the oyster can you see? What part am I touching? The outside, or shell. Where is the oyster? Inside the shell. What can you say the shell of the oyster is? It is its home. Can you tell me the names of any other fish that live in shells? Yes, the periwinkle, whelk, mussel. Is the shell of the periwinkle like the shell of the oyster? Is it like the shell of any of these fish? No, it is very different. Here is an oyster shell, what can you say about it? It is of a brownish colour. It is rough. It is made up of different pieces. Yes, when a shell is like this, we say it is scaly. Now, look at the inside of this shell, what can you say about it? It is bright. It is of a white colour. Some parts look like pearls. Which side of the oyster shell is the prettier? The inside.

Now, look at this oyster, and tell me how many shells it has? It has two shells. Are they both alike? No, one shell is flat, and the other part is larger, and has a large hollow in it. Which shell is the flat one? The top one. Yes, and it is not as rough as the under, or lower one.

I will now open this oyster; do you know what I shall have to use? A knife. Will my penknife do? No, it is too sharp, and not strong enough. Yes, the oyster is very hard to open. What do you see inside the shell? An oyster. Where is it? In the large, or lower shell. Can you move the shell away easily? No, the oyster is joined to it. What must I do, then? You must cut the oyster away from the shell. Tell me something about this oyster. It is soft, cold, slippery, and of a light colour. Do you see these pieces of flesh lying along the shell? They form what is called the *mantle* of the oyster. If you look carefully at the mantle, you will see something along the edge. What can you see? The edge is nearly black. This is called the *beard* of the oyster, and forms the gills. For what do fish use their gills? To breathe with.

II. *Uses.*—For what do we use oysters? For eating. They are considered very good food, and sometimes, when people are ill, they are ordered to eat oysters. Do you know why? To help them to get strong.

Then there are some oysters that are very valuable, because of pretty little things found in the shell. They are called pearls. Have you heard of pearls? Have you seen any? Mary says, her sister has a pearl necklace, and another little girl says her mother has a box made of pearl. This pearl is the inside part of the shell of the oyster. The little pearls I was telling you about are used to put in rings, lockets, pins, etc. It would be well for the teacher to show the children some jewellery containing pearls, so as to help them to distinguish between these pearls and the mother-of-pearl used for buttons, knife handles, in inlaying wood, etc.

III. *Where found.*—Where do all fish live? In the water. Can you tell me what most fish do in the water? Swim about. Does the oyster swim about? The oyster is not able to swim. It fastens itself to a piece of rock or stone, and remains there. Which shell do you think is fastened to the rock? The bottom one. A great many oysters are found together, and the place where they are found is called an oyster-bed. How do you think we get the oysters from the bottom of the water? Well, I will tell you. Men take out a small net, fastened to a round ring of iron. They let this down to the bottom and then drag it along, and thus scoop up the oysters, and many other things that are in the water. The oysters are then picked out, and sent to the shops for us to buy. The oysters containing the beautiful pearl for making buttons, etc., are not found near our country. They are brought from places a very long way off.

IV. *Summary.*—This should be written on the board as the lesson proceeds, and should consist of simple words. It should then be copied by the children, or read, and afterwards written from memory.

An oyster lives in two shells in the water.

A part of the oyster is called the mantle. The gills are called the beard. The oyster is used for food.

The shells of some oysters are used for making buttons, handles of knives, pretty boxes. This substance is called mother-of-pearl.

Small pearls for rings, lockets, etc., are also found in oysters.

LESSON—THE SPIDER.

CLASS—CHILDREN OVER SIX.

Apparatus:—Picture or enlarged drawing of a Spider.

I. *Description.*—Children to be shown the picture, and to be asked what it is. Yes, it is a spider. Have you ever seen one? Where? Sometimes in the corners of the rooms. How do you know there is a spider in the corner? You see a cobweb. What does your mother do when she sees a cobweb? She gets a broom and sweeps it away. Why? Because it looks dirty and untidy. What does the poor little spider have to do then? It has to go somewhere else and make its web. You may sometimes see them in gardens, on bushes and trees, and if you ever go into a cellar you will be sure to see some there.

I want you now to look at this large picture of a spider, and tell me all you can about it. Look at its head, do you see how it is joined to its body? Yes; the spider has no neck, its head is joined on to its body without a neck.

What has the spider in front of its head? Two long horns. Well, they are something like horns, but we call them pincers. Repeat, 'The spider has a pair of pincers in front of its head.' Do you know the use of these to the spider? It uses them to catch its food. Now you may count its eyes. How many can you see? Eight; two in front, two on each side, and two at the top. I wonder what is the use of all these eyes to the spider. How many have you? Only two. Where are they? In front of our head. What do you do when you want to see something at the side of you, or behind you? Turn our heads. Well, you see the spider has no neck, therefore it cannot turn its head about like we can, so what has it to enable it to see all round? Eyes in different parts.

Now let us see how many legs it has. Eight. It will be easy to remember that the spider has eight eyes and eight legs. Look at the legs again. What do you see at the end of them? Yes, they are like two hooks, something like the pincers. Where are the pincers? Quite right. They are in front of the head.

II. *Habits.*—Children to be asked what the spider has to eat. Flies and other insects. How does it catch these? In its web. Would you like to know how it makes its web? Well, I will tell you. The spider has in its body some juice, very thick and sticky, something like treacle. What colour is treacle? This juice is not the same colour as treacle, it is quite white. It is of this juice that the spider makes its web. When it wants to weave its web, the juice comes out of its body through very tiny holes, and makes a kind of thread. A drawing of the web might be shown and examined, the teacher pointing out how the threads cross one another, and are fastened at the ends. Why does the spider weave its web? To catch its food. How is it that the flies go into this net? The web is so fine that as the fly goes along quickly it does not see it and so is caught in it. Where is the spider? He is somewhere very near waiting for some food; directly he sees the fly caught he walks round and round it, all the time winding a thread round to fasten its wings and legs; then the spider pierces the fly with its pincers, and sends some poison into the holes made; the fly is thus killed, and the spider has its food. He then mends the web and watches for another insect.

III. *Summary.*—The spider's head is joined to its body without a neck. The spider has a pair of pincers in front of its head. It has eight eyes and eight legs, furnished with two hooks something like its pincers.

The spider lives on flies, gnats, and other insects, which it catches in its web.

It weaves its web of a substance which comes out of its body through little holes.

This should be written on the blackboard as the lesson proceeds, and at the end carefully read through by the children. If convenient, the children should copy it on their slates.

LESSON—THE COD.

CLASS—CHILDREN OVER SIX.

Apparatus: If possible, a small Cod might be shown to the children, or a picture of one; some smaller fish.

I. *Description.*—The smaller fish, *e.g.*, herring, haddock, mackerel, plaice, etc., to be brought before the children, who should be asked to name them. The cod now to be shown. What kind of fish would you say this is? A large one. Do you know its name? Yes, it is a cod. This is a very small cod; most of them are about as long as this—(show length of 2½ feet or 3 feet, the average length of the cod), and there has been one caught as long as this (show length 5 feet 8 inches.) What can you now tell me about the cod? It is a large fish. Are they all the same size? No. Then we say they vary in size. Now look at the head of the cod. If you feel it what do you find out? It is very smooth. Look at its body, where is it thickest? In the middle. Repeat: The cod's body is thicker in the middle than it is at the ends. With what is it covered? With scales. What is the colour of its body? It is different in different parts—in some places of a greenish colour, and in other parts white. What can you tell me about its mouth? It is large, and do you see what it has at the end of the lower part of its mouth? We call this a *beard.* Have you ever seen any one with a beard? Yes, some of your fathers have beards.

Where do they have them? On their chins. If you were to look inside the cod's mouth, do you know what you would see? Teeth. Yes, a great many teeth—several rows of them. How many rows of teeth have you? Only one. Repeat, 'The cod has several rows of teeth.'

Now see what the cod has on its back. Fins. Let us count them. Three on the back, two at the gills, two on the breast, and two near the tail. What is the use of the fins?

II. *Habits and food.*—Where does the cod live? In the sea. Is it found near our own country? Yes, but it is still more common near countries a very long way from here—they are much colder countries than ours. Men go out in ships to these places to catch the fish. What are these men called? Have you ever seen any one fishing? What do they use to catch the fish? Sometimes a net, and sometimes a long line with a hook at the end. Well, the men who go to catch cod use a hook and line. Some men catch a great many cod. What do they do with them when they have caught them? They put them in the ship and then bring them home.

What does the cod get to eat in the sea? Fish. Yes, they eat small fish and worms. They also eat crabs. What are crabs? Yes, they are fish. With what are they covered? With shells. Do you know any other fish covered with shell? We call all these shell-fish. The cod is very fond of eating shell-fish.

III. *Uses.*—For what do we use the cod? For food. What does your mother do with it? Boil it. How does the fish look when it is cooked? Very firm and white; it is very nice to eat. There is one part of the fish that is sold by itself, do you know what it is? The roe. This also is very nice when it is cooked. Do you know any other use of the cod? Have any of you ever tasted cod-liver oil? Some of you have had some. Why did you have it? It is a medicine, and people take it to make them well and strong. We get cod-liver oil from the cod—there is one part inside the cod called liver. You all know what liver is, and it is from this part that the oil is obtained.

IV. *Summary.*—The cod is a large fish. Its head is very smooth.

The cod's body is thicker in the middle than at the ends.

It is covered with scales. The cod has a large mouth, with several rows of teeth. It has a beard.

The cod has nine fins.

The cod lives on small fish and worms. It also eats shell-fish.

The cod is used for food. Cod-liver oil is obtained from its liver.

This should be written on the black board as the lesson proceeds.

(To be continued.)

—o—

Music.

BY RALPH DUNSTAN, MUS. BAC., CANTAB.;
L. MUS., T.C.L.;
Member of the Council of the Tonic Sol-fa College, etc.

(Continued from page 17.)

DIATONIC AND CHROMATIC INTERVALS.—By the addition of the 'Chromatics,' **fe, ta, de, ma,** etc., to the natural diatonic scale, many new intervals can be formed. In reckoning such intervals it will be necessary to bear constantly in mind the rule laid down in treating of diatonic intervals, viz., *the name of the interval* (second, third, fifth, etc.) *is reckoned according to the number of included* DEGREES *of the scale.*

Thus the intervals, **d-m, d-ma, de-m,** and **de-ma** are all *thirds*, including the degrees **d, r, m,** or inflections of these; and, by the same rule, the interval **d-la** is a *sixth* (**d, r, m, f, s, la**), while the interval **d-se** is a *fifth* (**d, r, m, f, se**): the number of semitones in each of these intervals is the same, but the names are quite distinct.

Seconds, thirds, sixths, and sevenths, which are *greater than Major*, are said to be '*Augmented*'; when *less than Minor* they are '*Diminished.*'

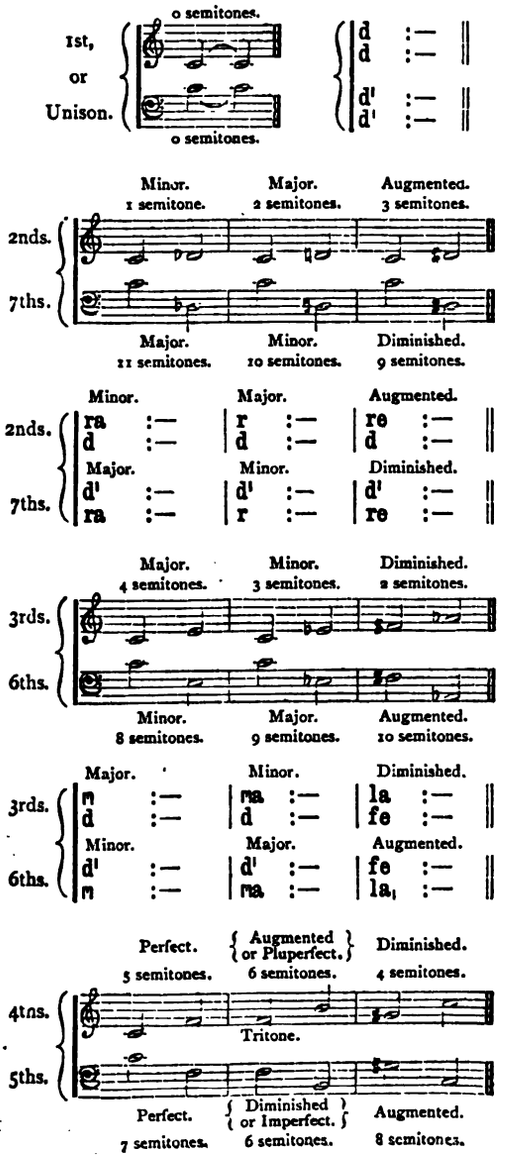
Fourths, fifths, and octaves, when *greater than perfect* are augmented or '*Pluperfect,*' when *less than perfect*, Diminished, or '*Imperfect.*'

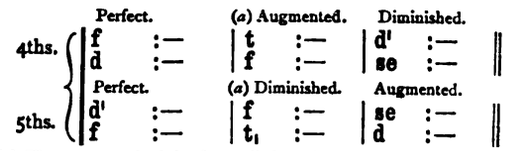
When 'inverted'

An *augmented*	interval	becomes	*diminished*
A *diminished*	,,	,,	*augmented*
A *pluperfect*	,,	,,	*imperfect*
An *imperfect*	,,	,,	*pluperfect*

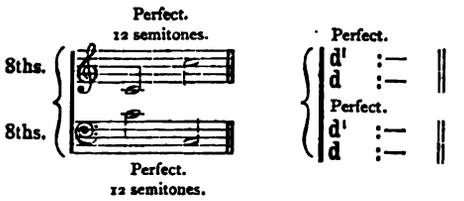
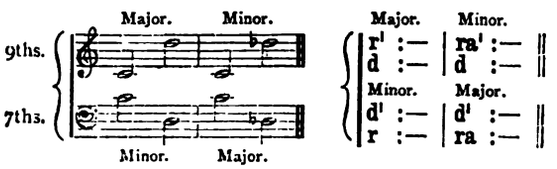
Table showing examples of the most important Diatonic and Chromatic intervals, with their Inversions and the number of included semitones.

N.B.—The lower interval is the inversion of the higher, and *vice-versa.*


1st, or Unison.
0 semitones.
0 semitones.
d :— d
d :— d
d' :— d'
d' :— d'
2nds. 7ths.
Minor. 1 semitone. Major. 2 semitones. Augmented. 3 semitones.
Major. 11 semitones. Minor. 10 semitones. Diminished. 9 semitones.
2nds.
Minor. ra :— d
Major. r :— d
Augmented. re :— d
7ths.
Major. d' :— ra
Minor. d' :— r
Diminished. d' :— re
3rds. 6ths.
Major. 4 semitones. Minor. 3 semitones. Diminished. 2 semitones.
Minor. 8 semitones. Major. 9 semitones. Augmented. 10 semitones.
3rds.
Major. m :— d
Minor. ma :— d
Diminished. la :— fe
6ths.
Minor. d' :— m
Major. d' :— ma
Augmented. fe :— la,
4ths. 5ths.
Perfect. 5 semitones. { Augmented or Pluperfect. } 6 semitones. Diminished. 4 semitones.
Tritone.
Perfect. 7 semitones. { Diminished or Imperfect. } 6 semitones. Augmented. 8 semitones.



(*a*) The augmented 4th is often called a *pluperfect* 4th or a *tritone*, and the diminished 5th an *imperfect* 5th.



TRANSITION AND MODULATION.—Staff-Notationists and Solfa-ists have different meanings for these words. According to the former, *Modulation* is any change of key or mode, and *Transition* implies a sudden or violent modulation.

Mr. Curwen restricted the uses of these words and made their signification more definite, so that in Solfa language *Transition* is *change of key*, and *Modulation* is *change of mode.*

For the present we shall adhere to these latter definitions.

TRANSITION, OR CHANGE OF KEY.—The whole theory of Transition is best shown by what is called the 'Extended Modulator.' On this modulator several scales are printed side by side in such a manner that the scale immediately to the right of any particular scale represents a key or scale whose Tonic or Key-note is a perfect-fifth *higher* than the Tonic or Key-note of that scale, the *DOH* of the one corresponding in pitch to the *SOH* of the other; thus—

m'	l
r'	s
DOH'	f
TE	m
LAH...	r
SOH...	*DOH*
fe	t_1
FAH...	ta_1
ME	l_1
RAY...	s_1
DOH...	f_1

The *Transition* implied by changing from the first of these scales to the second is equivalent to a change from the key of C to that of G (with *one* sharp), or from the key of G (with *one* sharp) to that of D (with *two* sharps); or from the key of B flat (with *two* flats) to that of F (with *one* flat), etc. Each note of the second scale corresponds with a note of the first scale with the exception of *TE*; this note, which is of course a *semitone* below *DOH*, is not the equivalent of *FAH*, a *tone* below *SOH*, but of *FE* the sharp of *FAH*. In other words, the *FAH* of the old scale is *sharpened a semitone* to *FE*, which becomes the *leading note*, *TE*, of the new scale.

As there is only *one* note of the old scale changed, and this note is *sharpened*, the process of changing from the first scale to the second is called 'a Transition of *one sharp remove*:' and there is, of course, one *new* note, *TE*.

By extending the process of transition to the next scale—

r' ... s	d'
de' ... *fe*... ...	t
DOH' ... f ...	*...ta*
TE... ... m	l
LAH ... r	s
SOH ...*DOH* ...	f
fe... ... t_1	m
FAH *ta*, ...	
ME ... l_1	r
RAY ... s_1	*DOH*
de... ... *fe*, ...	t_1
DOH ... f_1 ...	*...ta*,

It will be seen that the new *DOH* is equivalent in pitch to the old *RAY* (the whole scale has been raised a *tone* or *Major Second*), and there are *two* notes in this scale which do not correspond to diatonic notes of the former, viz., *TE* and *ME*: this is called 'a Transition of *two* sharp removes.'

Let us now *reverse* the process, reading the Modulator from right to left instead of from left to right.

(2)	(1)
s ...	*DOH'*
	... *TE*
f	...*ta*
m ...	*LAH*
r ...	*SOH*
DOH—FAH	
t_1 ...	*ME*
l_1 ...	*RAY*
s_1 ...	*DOH*

The *FAH* of the first scale becomes the *DOH* of the second, and the *TE* is lowered or flattened to *TA*, which becomes the *FAH* of the new scale. This is 'a Transition of one *flat* remove,' and the new note is *FAH*. Such a Transition which *lowers* the pitch of *DOH* a perfect fifth (or, what is the same thing, raises it a perfect fourth), is equivalent to a change of key from C to F (with *one* flat), or from F (with *one* flat) to B flat (with *two* flats), or from D (with *two* sharps) to G (with *one* sharp), etc.

By repeating the same process we get 'a Transition of *two* flat removes,' where the *DOH* is lowered a Major second, and the two new notes are *FAH* and *DOH*.

The student should procure a small 'Extended Modulator' (Messrs. Curwen and Sons), and by

attentive examination and study of it verify and learn by heart the following table :—

KIND OF TRANSITION.	EFFECT ON DOH.	NEW NOTES.
1 sharp remove	Raised Perfect 5th	t
2 ,, removes	,, Major 2nd	t, m
3 ,, ,,	Lowered Minor 3rd	t, m, l
4 ,, ,,	Raised Major 3rd	t, m, l, r
5 ,, ,,	Lowered Minor 2nd	t, m, l, r, s
6 ,, ,,	Raised Augmented 4th	t, m, l, r, s, d
7 ,, ,,	,, Chromatic Semitone	t, m, l, r, s, d, f
1 flat remove	,, Perfect 4th	f
2 ,, removes	Lowered Major 2nd	f, d
3 ,, ,,	Raised Minor 3rd	f, d, s
4 ,, ,,	Lowered Major 3rd	f, d, s, r
5 ,, ,,	Raised Minor 2nd	f, d, s, r, l
6 ,, ,,	,, Diminished 5th	f, d, s, r, l, m
7 ,, ,,	Lowered Chromatic Semitone	f, d, s, r, l, m, t

In the notation of Transitions, besides the new key and the 'bridge-tone' already explained, the *new note* or notes should also be shown; in *sharp* Transitions the new notes are placed to the *right* of the name of the new key, and in *flat* transitions to the *left;* thus :—

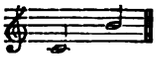
(*a*) Key D. | d :r .m | f .s :m | E. t.m. [r]d :r .m | f .s :m | d.f. D. [m] :r .t$_1$ | d :— ‖

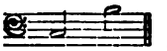
(*b*) Key F. | m :f :s | l :s .m :d | s.d.f. Ab. [ma]d :t$_1$:l$_1$ | l$_1$:se$_1$.l$_1$:t$_1$ | F. t.m.l. [l]d :r .m :r .t$_1$ | d :— :— ‖

MODULATION is a change of Mode, as from Major to Minor, or from Minor to Major.

When a change of *Key* is accompanied by a change of *Mode* it is called a TRANSITIONAL MODULATION, as in Ex. (*b*) above.

When translating music from the Staff Notation to the Sol-fa, the 'unmarked' *DOH* for Treble and

Alto parts lies in this part of the Staff 

and for Tenor and Bass parts in this 

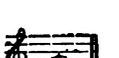
To prevent the multiplicity of 'Octave-marks,' Tenor and Bass parts are, in Sol-fa, always written an octave *higher* than the real sounds signified.

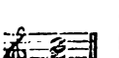
CHORDAL STRUCTURE OF THE SCALE.—When the notes **d, m, s,** are sounded together they produce what is called the '*Chord*' *of DOH.*

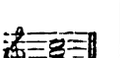
A *chord* is a combination of two or more notes sounded simultaneously, and the construction and treatment of chords form the basis of the theory of *Harmony.*

The 'Scale' is sometimes said to consist of the note of the Tonic, Dominant, and Sub-Dominant chords. These are,

In the Major Scale :—

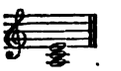
(*a*) Chord of Tonic (or Chord of *DOH*) ... ... {s, m, d} 

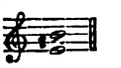
(*b*) Chord of Dominant (or Chord of *SOH*) ... ... {r', t, s} 

(*c*) Chord of Sub-Dominant (or Chord of *FAH*) ... ... {d', l, f} 

It will be seen that all the notes of the Major Scale are comprised in these three chords.

In the *Minor* Scale the corresponding chords are those of *LAH* (the Tonic), *SEME* (the Dominant), with *SE* instead of *SOH*, and *RAY* (the Sub-Dominant).

Chord of *LAH* {m, d, l$_1$} 

Chord of *SEME* {t, se, m}

Chord of *RAY* {l, f, r}

(To be continued.)

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Chemistry of the Non-Metallics.

BY EDWARD B. AVELING, D.Sc. LONDON.

[This series of articles, whilst dealing with the subjects required by the University of London for the Matriculation Examination and with those required at the Elementary Stage of the Inorganic Chemistry (Branch X.) Science and Art Department, is intended as a practical guide to the philosophical and systematic study of the non-metallics.]

CHAPTER III.—(*continued.*)

To sum up our simple table of weights and measures :

LENGTH.

Millimetre $\frac{1}{1000}$ metre about $\frac{1}{25}$ in.	*Metre* (39·37 in.)	Decametre 10 metres
Centimetre $\frac{1}{100}$ metre about $\frac{2}{5}$ in.		Hectometre 100 ,,
Decimetre $\frac{1}{10}$ metre about 4 in.		Kilometre 1000 ,,

VOLUME.

Millilitre $\frac{1}{1000}$ litre	*Litre* (1·765 imperial pints)	Decalitre 10 litres
Centilitre $\frac{1}{100}$,,		Hectolitre 100 ,,
Decilitre $\frac{1}{10}$,,		Kilolitre 1000 ,,

MASS.

Milligram $\frac{1}{1000}$ gram	*Gram* (15·432 grains)	Decagram 10 grams
Centigram $\frac{1}{100}$,,		Hectogram 100 ,,
Decigram $\frac{1}{10}$,,		Kilogram 1000 ,,
		about 2·205 lbs. av.

These weights and measures are in constant use in chemical laboratories, and in making chemical calculations. In connexion with every preparation and every reaction met with in our study of chemistry, these will be used. It is necessary, therefore, to at once familiarise the student with the working of these tables, and a few examples are taken before we proceed further.

EXERCISES ON WEIGHTS AND MEASURES, WITH SOLUTIONS.

(1) Find the equivalent in English measure of 3 kilometres, 2 hectometres.

3 kilometres = 3000 metres
2 hectometres = 200 metres } = 3200 metres.
1 metre = 39·37 inches
3200 metres = 39·37 × 3200 inches = 125984 inches
125984 inches = 10498 feet 8 inches = 3499 yds. 1 ft. 8 ins.
= 1 mile 1739 yards 1 foot 8 inches.

(2) Find the equivalent in English measure of 1 hectolitre 7 dectilitres.

1 hectolitre = 100 litres = 176·5 imperial pints
7 dectilitres = $\frac{7}{10}$ litre = 7 × ·1765 = 1·2355 pints } 177·7355.
177·7355 pints = 88·8677 quarts = 22·2169 gallons.

(3) Express 1 ton as its equivalent on the metric system.

1 ton = 20 cwt. = 2240 lbs. = 2240 × 7000 grains = 15680000 grains.

15·432 grains = 1 gram

1 grain = $\frac{1}{15{\cdot}432} = \frac{1000}{15432}$ grams.

15680000 grains = $\frac{1000 \times 15680000}{15432}$ = 1016070$\frac{970}{1929}$ grams.

= 1016 kilograms 7 decagrams $\frac{970}{1929}$ grams.

(4) The number of millimetres in 20·7 metres.

1 metre = 1000 millimetres

20·7 metres = 1000 × 20·7 = 20700 millimetres.

(5) The number of kilograms equivalent to 5004 milligrams.

1 milligram = $\frac{1}{1000}$ gram = $\frac{1}{1000} \times \frac{1}{1000}$ kilogram.

5004 milligrams = $\frac{1}{1000} \times \frac{1}{1000} \times 5004$ kilograms = $\frac{5004}{1000000}$ = ·005004 kilograms.

(6) The number of decalitres in 2000 centilitres.

1 centilitre = $\frac{1}{100}$ litre = $\frac{1}{100} \times \frac{1}{10}$ decalitre.

2000 centilitres = $\frac{1}{100} \times \frac{1}{10} \times 2000$ = 2 decalitres.

(7) The number of cubic centimetres (c.c.) in 5½ litres.

1 litre = 1 cubic decimetre = 1000 c.c.

5½ litres = 1000 × 5½ = 5500 c.c.

(8) The number of cubic metres in a kilolitre.

1 kilolitre = 1000 litres = 1000 cubic decimetres.

10 decimetres = 1 metre ∴ 1000 cubic decimetres = 1 cubic metre, and 1 kilolitre = 1 cubic metre.

(9) The weight of 2 hectolitres of distilled water.

1 hectolitre = 100 litres = 100 cubic decim. = 100 × 1000 c.c.

1 c.c. of distilled water weighs 1 gram.

∴ 1 hectolitre weighs 100 × 1000 grams = 100 kilograms, and 2 hectolitres weigh 200 kilograms.

(10) The weight of a kilolitre of a liquid of specific gravity 5.

(Water is the standard of reference for liquids.)

1 c.c. of water weighs 1 gram.

1 kilolitre = 1000 litres = 1000 × 1000 c.c.

∴ 1 kilolitre of water weighs 1000000 grams.

1 kilolitre of liquid of specific gravity 5 weighs 5000000 grams = 5000 kilograms.

EXAMPLES ON WEIGHTS AND MEASURES FOR SOLUTION.

(1) Find the English-system equivalents of the following (the answers are in italics) :—

(*a*) 27 metres ...	29 *yards*, 1 *foot*, 6·99 *inches*.
(*b*) 4 hectometres, 8 metres, 7 decimetres	446 *yards*, 2 *feet*, 10·519 *inches*.
(*c*) 1 centimetre ...	·3937 *inches (nearly ⅜ inch)*.
(*d*) 1 millimetre ...	·03937 *inch (nearly 1/25 inch)*.
(*e*) ·6 of a litre ...	1·059 *pints*.
(*f*) 7 kilolitres 7 millilitres	1544 *gallons*, 1 *quart*, 1·012355 *pints*.
(*g*) 2 cubic metres ...	441 *gallons*, 1 *quart*.
(*h*) 1 kilogram ...	2 lbs., 1432 *grains*
(*i*) 5·75 hectograms...	1 *lb.*, 1873·4 *grains*.
(*k*) 1 milligram ...	·015432 *grains*.

(2) Find the metric-system equivalents of the following :—

(*a*) 1 mile	1 *kilometre*, 6 *hectometres*, 9·3 *metres*.
(*b*) 1 foot	3 *decimetres*, ·4 *centimetres*.
(*c*) 1 inch	2 *centimetres*, 5 *millimetres*.
(*d*) 4 gallons	18 *litres*, 1 *decilitre*, 3 *centilitres*.
(*e*) 3 quarts	3 *litres*, 3 *decilitres*, 9 *centilitres*.
(*f*) 7 gallons, 2 quarts, 1 pint	3 *decalitres*, 4 *litres*, 5 *decilitres*, 6 *centilitres*.
(*g*) 1 lb.	4 *hectograms*, 5 *decagrams*, 3 *grams*, 6 *decigrams*.
(*h*) 3 qrs., 26 lbs. ...	49 *kilograms*, 8 *hectograms*, 9 *decagrams*, 6 *grams*.
(*i*) 7·716 grains ...	5 *decigrams*.

(3) Perform the following reductions :—

(*a*) 5 kilometres to millimetres ...	Ans. 5,000,000
(*b*) 84550 centimetres to kilometres ...	,, ·8455
(*c*) 9¾ metres to millimetres	,, 9750
(*d*) 2·8 litres to millilitres	,, 2800
(*e*) 6 kilolitres to centilitres	,, 600,000
(*f*) 7 decalitres to cubic centimetres ...	,, 70,000
(*g*) 3·5 litres to cubic centimetres ...	,, 3,500
(*h*) 9 kilograms to decigrams	,, 90,000
(*i*) 17564 milligrams to grams ...	,, 17·564
(*k*) 4 hectograms, 9 grams to milligrams	,, 409,000

(4) Find the weights of the following (the answers are in italics) :—

(*a*) Half a litre of distilled water ...	5 *hectograms*.
(*b*) A cubic decimetre of alcohol (sp. gr. = ·8)	8 *hectograms*.
(*c*) A cubic millimetre of mercury (sp. gr. = 13·5)	1 *centigram*, 3·5 *milligrams*.
(*d*) A cube of iron 3 decimetres in the side (sp. gr. = 7)	189 *kilograms*
(*e*) A rod of copper 2 metres long, section, 2 square c. m. (sp. gr. = 9)	3 *kilograms*, 6 *hectograms*.

The metric system of weights and measures once understood, we can turn again to our preparation of hydrogen. The symbols of the preparation of that element from zinc and sulphuric acid were : $Zn + H^2SO^4 = ZnSO^4 + H^2$. To calculate the proportionate weights of the substances employed and of the substances formed in this reaction, we turn to the table on p. 12. The weight-numbers of hydrogen, sulphur, oxygen given there are respectively, 1, 32, 16. The weight-number of zinc is 65. Hence that of sulphuric acid (H^2SO^4) = 1 × 2(H^2) + 32(S) + 16 × 4(O^4) = 2 + 32 + 64 = 98: and that of zinc sulphate ($ZnSO^4$) = 65(Zn) + 32(S) + 16 × 4(O^4) = 65 + 32 + 64 = 161. We re-write the equation with the weight-numbers beneath the symbols.

$$\begin{array}{lcl} Zn + H^2SO^4 & = & ZnSO^4 + H^2 \\ 65 + 2 + 32 + 64 & = & 65 + 32 + 64 + 2 \\ \underbrace{\qquad\qquad}_{98} & & \underbrace{\qquad\qquad}_{161} \end{array}$$

From this we learn that 65 parts by weight (say grams or pounds) of zinc require 98 parts by weight of sulphuric acid for solution, and that 161 parts by weight of zinc sulphate are formed while 2 parts by weight of hydrogen are liberated. These are the fixed proportions by weight. If more than 98 parts by weight of the acid are poured upon 65 of zinc, only 98 will be affected, and all above that number will be untouched. For example, if on 65 grams of zinc a hectogram of the acid are poured, 2 grams of acid will be left.

We are now in a position to make the first of our chemical calculations. Wherever a question is given upon the weights of materials employed or produced in any given reaction, three things are necessary to its solution. (1) The symbols of the reaction. (2) The general weight-numbers. (3) The particular calculation.

EXERCISES ON THE PREPARATION OF HYDROGEN FROM ZINC AND SULPHURIC ACID. (*Solved.*)

(11) 5 grams of hydrogen are required. How much zinc and sulphuric acid are necessary for its production ?

$$\begin{array}{lcl} Zn + H^2SO^4 & = & ZnSO^4 + H^2 \\ 65 + 98 & = & 161 + 2 \end{array}$$

For 2 grams hydrogen, 65 grams zinc, and 98 grams sulphuric acid are needed.

1 ,, $\frac{65}{2}$,, $\frac{98}{2}$,,

5 ,, $\frac{65 \times 5}{2}$,, $\frac{98 \times 5}{2}$,,

∴ $\frac{325}{2}$ = 162½ grams zinc + $\frac{490}{2}$ = 245 grams of acid.

(12) What weight of hydrogen can be obtained from 9·8 grams of sulphuric acid ?

98 grams sulphuric acid yield 2 grams hydrogen.

1 ,, ,, ,, yields $\frac{2}{98}$,, ,,

9·8 ,, ,, ,, yield $\frac{2}{98} \times \frac{98}{10} = \frac{1}{5}$ gram hydrogen.

(13) 13 grams of zinc are dissolved in sulphuric acid. What weight of zinc sulphate is formed ?

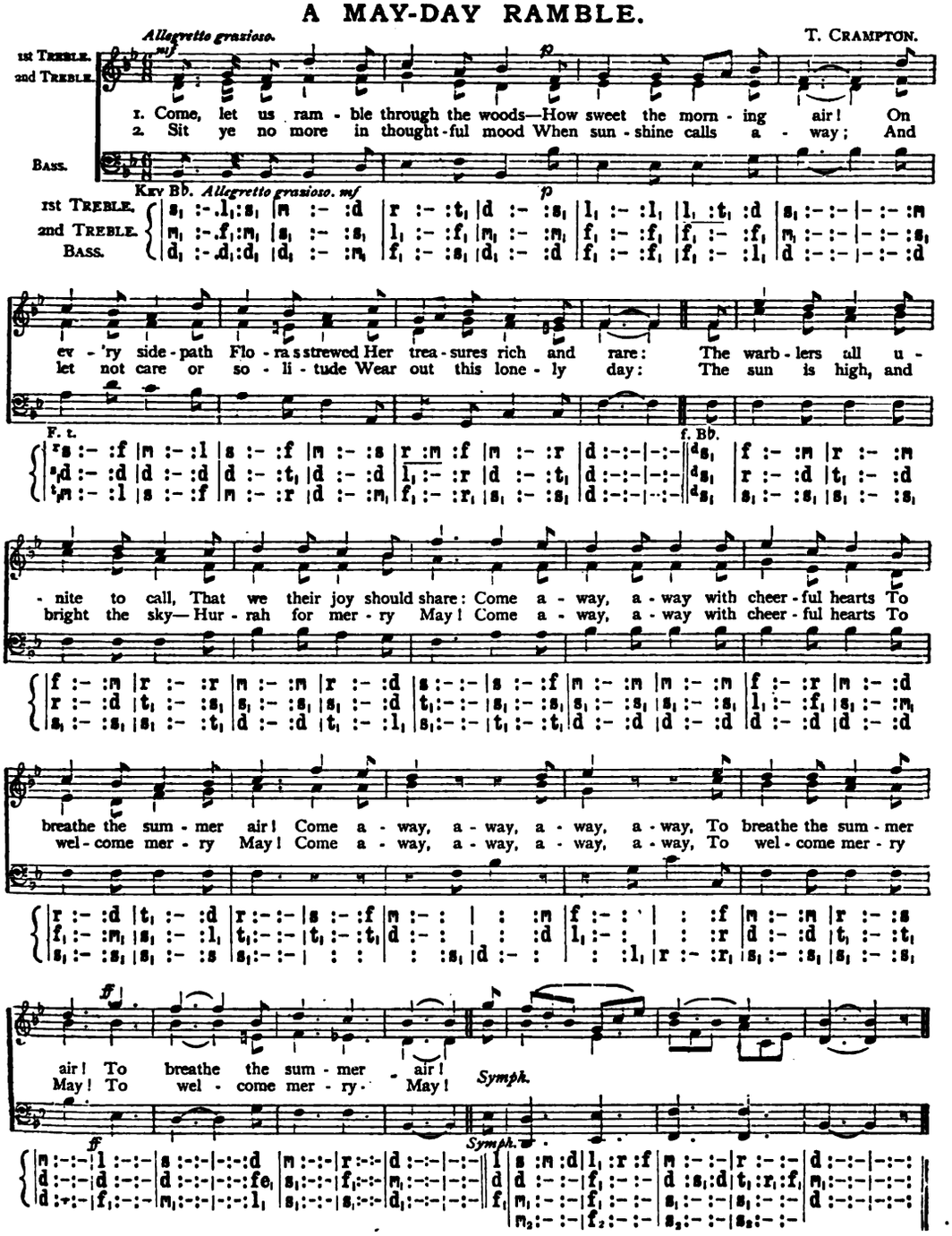
65 grams of zinc dissolved yield 161 grams $ZnSO^4$

1 ,, ,, ,, yields $\frac{161}{65}$,, ,,

13 ,, ,, ,, yield $\frac{161 \times 13}{65} = 32\frac{1}{5}$ grams.

(To be continued).

A MAY-DAY RAMBLE.


Allegretto grazioso.
mf
T. CRAMPTON.
1st TREBLE.
2nd TREBLE.
BASS.
1. Come, let us ram - ble through the woods—How sweet the morn - ing air! On
2. Sit ye no more in thought-ful mood When sun - shine calls a - way; And
p
KEY Bb. Allegretto grazioso. mf
ev - 'ry side-path Flo - ra's strewed Her trea - sures rich and rare: The warb - lers all u -
let not care or so - li - tude Wear out this lone - ly day: The sun is high, and
F. t.
f. Bb.
- nite to call, That we their joy should share: Come a - way, a - way with cheer - ful hearts To
bright the sky—Hur - rah for mer - ry May! Come a - way, a - way with cheer - ful hearts To
breathe the sum - mer air! Come a - way, a - way, a - way, a - way, To breathe the sum - mer
wel - come mer - ry May! Come a - way, a - way, a - way, a - way, To wel - come mer - ry
ff
air! To breathe the sum - mer air!
May! To wel - come mer - ry - May!
Symph.
Symph.

BEHAVIOUR.

In marching time. *mf* *Words and Music by* T. CRAMPTON.

1st TREBLE. 2nd TREBLE. BASS.

1. In en - t'ring a - ny room at first, Step light - ly on the
2. And when the teach - er gives the word For pu - pils all to
3. The word to *Halt!* (5) is firm - ly given, Then all must stop at

floor; Then greet all pre - sent with a (1) bow, And gen - tly close the door:
(3) rise, Each one the or - der to o - bey With prompt at - ten - tion tries:
once; And he who knows not (6) left from (7) right, Must sure - ly be a dunce!

And al - ways when they come to school— 'Tis right for girls and
And when the word to (4) *March!* is given, With stea - dy pace all
While in the ranks all (8) stand e - rect, And strict at - ten - tion

boys To take their pla - ces qui - et - ly, And (2) sit down with - out noise.
go; And each to keep step well and true Will good at - ten - tion show.
pay; But when the word *Break ranks!* (9) is given, All start for mer - ry play.

Key C. *In marching time. mf*

1st TREBLE. 2nd TREBLE. BASS.

.s	d'	.s	:d'	.s	l	.d'	:s	.d'	r'	.d'	:r'	.t	d'	:-	.m'
.m	m	.m	:m	.m	f	.f	:m	.m	f	.m	:f	.r	m	:-	.s
.d	d	.d	:d	.d	f	.l	:d'	.d	s	.s	:s	.s	d	:-	.d

d'	:-	.m'	r'	.t	:d'	.r'	t	.s	:m	.d'	t	.s	:fe	.l	s	:-	.
m	:-	.s	s	.s	:fe	.fe	r	.r	:d	.m	r	.t	:d	.d	t_1	:-	.
d	:-	.d	t_1	.s	:l	.r	s	.t	:d	$.l_1$	r	.r	:r	.r	s	:-	.

.s	r'	.t	:r'	.r'	m'	.d'	:s	.m'	m'	.r'	:r'	.d'	t	:-	.s
.s	s	.s	:s	.s	s	.m	:m	.s	l	.l	:l	.fe	s	:-	.f
.t	t	.s	:t	$.t_1$	d	.d	:d'	.d'	f	.f	:fe	.r	s	:-	.t

t	:-	.s	s	.m'	:d'	.s	l	.f'	:r'	.d'	d'	.t	:l	.t	d'	:-	.
s	:-	.f	m	.s	:s	.s	f	.l	:l	.s	f	.f	:f	.f	m	:-	.
s	:-	.t	d'	.d	:m	.m	f	.r	:f	.m	r	.r	:s	.s	d	:-	.

(1) Bow. (2) Sit down. (3) Rise. (4) March in time, keeping step. (5) Stop suddenly.
(6) Point to the left. (7) Point to the right.
(8) Stand erect, in soldier-like attitude. (9) All scamper off to play, unless previously otherwise directed.

Physiology.

BY ARTHUR NEWSHOLME, M.D. LOND.,

Gold Medallist and University Scholar, Physician to the City Dispensary.

Functions of the Liver.—It will have been seen, from the study of the anatomy of the liver, that it is supplied with both venous and arterial blood, the former from the portal vein, the latter from the hepatic artery. The venous blood supplying the greater part of the liver is brought from two sources—the alimentary canal and the spleen. The blood from the alimentary canal will vary in composition according to the stage of digestion and the character of the food. As a rule it is deficient in solid matters, especially in red corpuscles, owing to dilution with the water absorbed, but contains an excess of albumin. The blood from the spleen is deficient in red corpuscles, but contains an excess of white corpuscles; while the total amount of solids is decreased. The blood of the portal vein combines the peculiarities of its two sources.

The blood leaving the liver by the hepatic vein is, as a rule, thicker than ordinary venous blood. The fibrin, albumin, fats, and salts in it are diminished, while the extractive matter is increased.

The character of the blood entering and leaving the liver is important, as throwing considerable light on its functions. These functions may be summed up under three heads:

1. It secretes bile.
2. It forms glycogen.
3. It alters certain constituents of the blood, and probably, as a consequence of this,
4. It forms one of the chief sources of the bodily heat.

The secretion of bile is the most obvious, though probably not the most important of the hepatic functions.

Bile is a bright, golden-red liquid when not modified by retention in the gall-bladder. It has a bitter taste, and is alkaline in reaction. Its specific gravity varies from 1018 to 1025. When taken from the gall-bladder it always contains considerable mucus, but when taken directly from the hepatic duct there is little or none of this. Besides mucus, its chief constituents are—bile-salts, cholesterin, bile-pigment, and inorganic salts.

The average amount of these is shown in the accompanying table.

	In 100 parts.
Water	86
Bile-salts	9
Fats, etc.	1
Cholesterin	0·25
Mucus and Pigment	3·
Inorganic Salts	0·75
	100

Bile differs from all other alimentary secretions in containing no proteids. Among the salts is a considerable proportion of common salt, some phosphates, iron, manganese, and, occasionally, a trace of copper.

The *bile-pigment* present in healthy human bile is *bilirubin*, the composition of which is $C_{16} H_{18} N_2 O_3$. The characteristic test for its presence (Gmelin's test) is the reaction obtained by adding a few drops of nitric acid to a little bile placed on a white plate. The yellowish-red becomes green, then in succession blue, violet, dirty red, and finally pale yellow. An alkaline solution of bilirubin exposed to the action of the air turns green, and becomes changed into *biliverdin*, which is the normal green pigment of the bile of herbivorous animals.

The bile occasionally vomited is green, and it is probable that biliverdin has been produced in it by the action of gastric juice. The bile pigments seem to be connected in their origin with the red corpuscles of the blood, and it is probable that they, on the other hand, produce the urinary pigment.

The *bile-salts* consist of sodium salts of glycocholic and taurocholic acids. The proportion of these two varies in different animals. In human bile the taurocholate of sodium exists almost to the exclusion of the glycocholate, while in ox-gall the reverse condition holds good. Both salts may be made to crystallise out of bile in needle-shaped crystals. They may be separated from a solution containing them both by sugar of lead, which throws down the glycocholate much more readily than the taurocholate. Both glycocholic and glycocholic acids are conjugate acids, consisting of cholalic acid conjugated in the first case with glycocholl, and in the second case with taurin. Glycocholl $= C_2 H_5 NO_2$, is amido-acetic acid, while taurin $= C_2 H_7 NSO_3$ is amido-ethyl-sulphuric acid. The decomposition of the biliary acids into the parts of which they are conjugated, occurs naturally in the intestine, taurin and glycocholl being returned to the circulation. The reaction may be expressed thus:

Glycocholic acid + Water = Cholalic acid + Glycocholl.

$$C_{26} H_{43} NO_6 + H_2O = C_{24} H_{40} O_5 + C_2 H_5 NO_2$$

Taurocholic acid + Water = Cholalic acid + Taurin.

$$C_{26} H_{45} NSO_4 + H_2O = C_{24} H_{40} O_5 + C_2 H_7 NSO_3$$

The presence of either of the bile-salts or acids may be detected by the addition of cane-sugar and sulphuric acid, a magnificent purple being developed (Pettenkofer's test).

The bile has been credited with most important digestive action, but there can be no doubt that this is to a large extent a mistake. It has no solvent action on any article of diet, owing to the fact that it contains no ferment analogous to ptyalin, pepsin, or trypsin. It has, however, certain minor functions:—1. It facilitates *the emulsification of fats*, probably owing to its alkaline character. The pancreatic juice is, however, much more important in this respect. It is found that animals in whom the bile is drained away by a fistula (an opening artificially made communicating with the exterior) of the bile-duct, rapidly emaciate. This has been ascribed to the loss of the emulsifying power of bile; but it is possible that it may be due also to derangement of the glycogenic function of the liver.

2. It *saponifies fats* to a certain extent, in virtue of the choleate of soda it contains.

3. It seems *to favour absorption of emulsified fats* by the villi of the intestine, as in its absence this process is not so rapid.

4. It *prevents unnatural decomposition* of the intestinal contents, and thus is antiseptic in its effect.

5. It *stimulates peristalsis*, and is consequently slightly purgative. When the bile is absent or deficient in amount, constipation is common.

6. It is *recrementitious*, being an excretion of waste

matter, and not chiefly a digestive secretion. This is shown especially in the fætus. In intra-uterine life, the lungs and intestinal canal are inactive, and there is absolutely no respiration. At birth the intestine contains a large amount of thick bile, which forms the largest part of the *meconium* or fœtal fæces. Thus the liver excretes in fætal life the oxidisable materials which might have been excreted in an oxidised condition from the lungs, if respiration had been in action. It is possible that in extra-uterine life also, the bile is excreted from the liver as in part an effete material. That this is not entirely the case, is shown by the fæces of children and adults containing only about one-sixteenth part of the bile, and none of its essential part, the bile-salts. It is evident, then, that the larger proportion of the bile becomes absorbed from the intestinal mucous membrane, and, as it contains an excess of carbon and hydrogen, furnishes a valuable source of combustible material, which is eventually eliminated by the lungs and kidneys.

The *source of the bile* has been the subject of much discussion. Do the hepatic cells elaborate and secrete the biliary constituents, or simply filter them from the blood? According to Drs. Budd and G. Harley, only the bile-salts are formed in the liver, while the bile-pigment is formed in the blood. The evidence is somewhat dubious, but it seems, on the whole, to favour the view that both are formed in the hepatic cells. This is borne out (1) by analogy; in the case of the pancreas we shall find quite as complex an elaboration effected; and (2) by the fact that extirpation of the liver does not produce any accumulation of bile in the blood.

It is probable, however, that although the bile is in the main elaborated by the liver, some of its constituents are partially or completely formed in the blood. Thus, according to Dr. Austin Flint, cholesterin represents the waste matter of the nervous tissues. Bile-pigments arise from hæmoglobin, and only a very slight transformation is necessary. Glycocholl, again, is normally present in the liver, and taurin in certain tissues, so that the bile-salts may be formed in the liver if only cholalic acid is there produced.

The *glycogenic function of the liver* is most important in maintaining the general nutrition. When this function fails, and sugar is allowed to enter into the circulation in unlimited amount, the disease known as diabetes is produced, which generally proves fatal in the end.

Claude Bernard first proved that animals are sugar-producers as well as plants, and carnivora as well as herbivora. The sugar-producing function appears to begin in the liver as early as the third or fourth month of fœtal life; before this time, the placenta seems to perform a similar function. In the adult this function is chiefly confined to the liver, though all the tissues possess it in a slight degree. Sugar is not formed immediately, but an intermediate substance, known as glycogen.

Claude Bernard found that the quantity of sugar was much greater in the hepatic than the portal vein; also that when a stream of water had been driven through the portal vein, thus depriving the liver of its contained blood, the quantity of sugar went on increasing for some hours after death. It is evident from this, that the substance of the liver contains a large amount of some material capable of producing sugar.

Claude Bernard next found that if the liver of an animal was removed directly after death, cut up into small pieces and thrown into boiling water, the resulting infusion contained very little sugar, and the quantity did not go on increasing for several hours. The fluid, however, was milky in appearance, and contained *glycogen*, a substance which could be changed into sugar by means of saliva and gentle warmth. It is evident, therefore, that boiling the liver destroyed a ferment, which would otherwise have rapidly converted glycogen into sugar; and we may regard the liver as a storehouse of glycogen, which is converted by means of this ferment into sugar, as the system requires.

Glycogen is identical in composition with starch ($C_6 H_{10} O_5$). It is an amorphous powder, soluble in water, but insoluble in alcohol or ether. By means of saliva or pancreatic juice, or the special ferment contained in the liver, as well as by many dilute acids, it is converted into grape-sugar. It differs from starch in its solubility in water, and in giving a deep red colour on the addition of iodine.

The immediate *origin of glycogen* is from the hepatic cells. They form a storehouse in which it is reserved until required, just as in the vegetable world starch is stored in roots and tubers, to be liberated in spring as dextrose for purposes of growth. The ultimate origin of glycogen, however, is the food. During starvation it diminishes and finally disappears. The foods which most rapidly and greatly increase it are starchy and saccharine. It may, however, be produced from a meat diet, though in much smaller amount. This is shown in some of the severer forms of diabetes. In these, the formation of large quantities of sugar continues, when a strict meat diet is enforced. One must conclude, therefore, that sugar (and consequently glycogen) may be formed by the breaking down of nitrogenous material into urea and the carbohydrate.

The fate of hepatic glycogen is still somewhat involved in mystery. It has been held that it becomes converted into fat and into sugar.

The formation of fat from glycogen is difficult to understand from a chemical point of view. That such a conversion seems possible, however, is favoured (1) by experiments of Milne-Edwards, who found that bees were able to make their combs (composed of wax—a kind of fat) when fed solely on sugar; while, at the same time, they did not diminish in weight. (2) There can be no doubt that an increase of carbohydrate (starchy and saccharine) food does tend to produce corpulence; while (3) there is considerable fat in the hepatic cells. It is probable, however, that carbohydrate food increases fat by acting as a source of readily combustible material, thus saving the combustion of fatty material already contained in the tissues, rather than by being directly converted into fat.

The conversion of glycogen into sugar readily occurs, as already seen. Whether, however, this change occurs in the living animal or not is still in dispute; most physiologists holding with Claude Bernard that it is constantly going on, while Dr. Pavy maintains that it is a purely *post-mortem* phenomenon, and asserts that the blood in the hepatic vein does not contain more sugar than that in the portal vein. It is doubtless true that the hepatic vein blood does not contain during life the amount of sugar found after death; but the estimation of sugar in blood is difficult, and it seems

probable that the sugar, after being temporarily stored in the liver as glycogen, leaves it as sugar, in an amount varying with the requirements of the system.

But whether the glycogen leaves the liver as glycogen or as sugar, its ultimate fate is to be used in *building up new tissues*. This is abundantly shown by its presence in muscle, white corpuscles, brain, and in all growing parts. It forms an essential part of these, and is a source of combustible material, producing heat and force for the body. A certain percentage of sugar is always contained in the blood, and seems to form an essential constituent of it.

The liver has a peculiar power of arresting matters passing through it, which is not confined to glycogen. Thus metallic poisons tend to accumulate in it, before entering into the general circulation.

The glycogenic function of the liver is closely under the control of the central nervous system. This is shown by the fact that if the medulla oblongata of a rabbit be pricked at the point known as the vaso-motor centre, the urine of the animal speedily contains sugar—in fact, an artificial diabetes has been produced. It seems that when the nervous control is deranged, the retentive power of the hepatic cells for glycogen is annihilated, and sugar passes through the liver without any hindrance.

The liver plays an important part in *modifying the constitution of the blood*. Some of the red corpuscles appear to be broken down in it, and from their colouring matter is produced the bile and urinary pigments. It is highly probable that the main seat of the metabolic changes, resulting in the production of uric acid and urea from albuminoid materials, is in the liver; for when the liver is disordered, this metabolism is somewhat diminished. In a disease called acute atrophy of the liver, in which the secreting tissue of the liver becomes destroyed, urea and uric acid almost cease to be formed, and leucin and tyrosin—bodies intermediate between urea and albumin—take their place.

(To be continued.)

—o—

ANSWERS TO

Pupil Teachers' Examination Papers.

MARCH 29.

FIRST YEAR.

Pupil Teachers at end of First Year.

Three hours and a half allowed.

Arithmetic.

MALES.

1. What is meant by a prime number, and by a composite number? When are two numbers said to be prime to each other? Write down (1) all the prime, (2) all the composite, numbers from 1 to 12, both inclusive.

A prime number is a *first number*, that is, one which is divisible only by itself or unity.

A composite number is one which is made up of two or more factors other than unity.

Two numbers are said to be prime to each other when neither will divide the other without a remainder.

(1) Prime numbers:—1, 2, 3, 5, 7, 11.
(2) Composite numbers:—4, 6, 8, 9, 10, 12.

2. What decimal of £2 5s. is equal to 13s. 7½d.; and what is the value in weight of ·428517 of ·78125 cwt.?

(*a*) Fraction required = 13s. 7½d. ÷ £2 5s.

$$= \frac{13\text{s. } 7\tfrac{1}{2}\text{d.}}{45}$$

$$= \frac{13\tfrac{1}{2}}{45}$$

$$= \frac{109}{360} = 3\cdot027. \text{ Ans.}$$

(*b*) ·428517 of ·78125 cwt.

$$= \frac{428517}{1000000} \times \frac{78125}{100000}$$

$$= \frac{3}{7} \times \frac{25}{32}$$

$$= \frac{75}{224}$$

= 1 qr. 9 lbs. 8 ozs. Ans.

3. Find the value of ·135 × 50·83 ÷ ·04091.

$$\cdot135 \times 50\cdot83 \div \cdot04091$$

$$= \frac{135-1}{990} \times \frac{5083-508}{90} \div \frac{4091-4}{99900}$$

$$= \frac{134}{990} \times \frac{4575}{90} \times \frac{99900}{4087}$$

$$= \frac{1340}{1}$$

$$= 168\cdot18. \text{ Ans.}$$

4. If A can do ⅔ of a piece of work in 5½ days, and B ⅘ of it in 4½ days, how much longer would A take to do the whole work than B would take?

Time for A to do ⅔ work = 5½ days.

" " 1/2 " $= \frac{5\frac{1}{2}}{3}$

" " 3/2 " $= \frac{5\frac{1}{2} \times 4}{3} = 7\frac{1}{3}$ days.

Time for B to do ⅘ work = 4½ days.

" " 1/5 " $= \frac{4\frac{1}{2}}{5}$

" " 7/5 " $= \frac{4\frac{1}{2} \times 7}{5} = 6\frac{3}{10}$ days.

∴ A would take longer than B, $7\frac{1}{3} - 6\frac{3}{10} = 1\frac{1}{30}$ days. Ans.

FEMALES.

1. Find the cost of 214 acres 3 r. 29 poles at £125 7s. 6d. per acre.

	£	s.	d.	
2 r. = ½ acre	125	7	6	= cost of 1 acre.
	214			
	26,830	5	0	= cost of 214 acres.
1 r. = ½ of 2 r.	62	13	9	= " 2 roods.
20 p. = ½ of 1 r.	31	6	10½	= " 1 rood.
5 p. = ¼ of 20 p.	15	13	5¼	= " 20 poles.
4 p. = ⅕ of 20 p.	3	18	4⅕	= " 5 poles.
	3	2	8⅘	= " 4 poles.
£	26,947	0	1 1/20	= cost of 214 a. 3 r. 29 ps.

2. Make out the following bill:—

11½ yds. muslin at 1s. 3d. per yd.
3½ yds. calico at 8½d. per yd.
16½ yds. flannel at 1s. 4d. per yd.
20½ yds. calico at 8½ per yd.
13¾ yds. print at 7½ per yd.
20 yds. sheeting at 1s. 6½d. per yd.
1 gross reels of cotton at 9d. per dozen.

Glasgow, March 29th, 1884.

Mr. Wm. Davey.

Bought of STEWART MCDONALD.

	£	s.	d.
11½ yds. muslin at 1s. 3d. per yd.	0	14	0⅜
3½ yds. calico at 8½d. per yd.	0	2	6⅛
16½ yds. flannel at 1s 4d. per yd.	1	1	8
20½ yds. calico at 8½d. per yd.	0	14	6½
13¾ yds. print at 7½ per yd.	0	8	7½
20 yds. sheeting at 1s. 6½d. per yd. ...	1	10	10
1 gross reels of cotton at 9d. per dozen ...	0	9	0
	£5	1	2⅜

3. Find the value of $3 + \frac{2}{3} + 1\frac{1}{2} + \frac{3}{4} + 103\frac{1}{3}$.

$$3 + \frac{2}{3} + 1\frac{1}{2} + \frac{3}{4} + 103\frac{1}{3}$$

$$= 107\frac{30+9+8+12}{36}$$

$$= 107\frac{59}{36}$$

$$= 108\frac{23}{36}. \text{ Ans.}$$

4. What is the shortest length of a wall that can be *exactly* measured with tapes either of 54, 216, or 168 inches in length?

Length required = L.C.M. of 54, 216, 168.

6	54, 216, 168
9	9, 36, 28
4	1, 4, 28
	1, 1, 7

$6 \times 9 \times 4 \times 7 = 1512$ inches. Ans.

Grammar.

MALES AND FEMALES.

1. *What* wicked and *dissembling* glass *of mine*,
Made me *compare* with Hermia's sphery *eyne*?
(Midsummer Night's Dream.)

Unruly *murmurs*, or ill-timed *applause*,
Wrong the *best* speaker, and the justest cause.
POPE.

Analyse the first of these sentences, and parse all the words in both printed in italics.

SUBJECT.	PREDICATE.	OBJECT.	EXTENSION.
What wicked and dissembling glass of mine	made	me Dir. Obj. compare with Hermia's sphery eyne Ind. Obj.	

What—interrog. pro., used as an adj. of distinction qualifying 'glass.'
dissembling—pres. part. of 'to dissemble,' used as an adj. of quality, qualifying 'glass.'
of—prep. showing reln. between 'glasses' und. and 'glass.'
mine—pers. pro., masc. (or fem.), 1st, sing., poss., gov. by 'glasses' und.
or, poss. pro., masc. (or fem.), sing., obj., gov. by 'of.'
compare—reg. int. verb, inf. mood., pres. tense, gov. by the verb 'made.'
eyne—com. noun, plu. no., neut., 3rd, obj., gov. by prep. 'with.'
murmurs—com. noun, plu., neut., 3rd, nom. to 'wrong.'
applause—com. noun, sing., neut., 3rd, nom. to 'wrongs,' included in the word 'wrong.'
wrong—reg. trans. verb, act., ind., pres., 3rd, sing., agreeing with its nom. 'murmurs.'
best—adj. of quality, superlative deg., qualg. 'speaker.'

2. What old plural ending do you notice in the above? Give similar instances.

Eyne for *eyes*; *hosen* and *hone* for *hose*; *treen* for *trees*; *pesen* for *peas*; *toon* for *toes*; *shoon* for shoes; *housen* for *houses*.

3. Mention some common terminations of English adjectives, with examples.

en, as—golden, wooden, hempen.
ful, as—playful, hurtful, wonderful.
ish, as—whitish, blackish, boyish.
less, as—houseless, fatherless, friendless.
ly, as—lovely, daily, weekly.
some, as—handsome, winsome, frolicsome.
ward, as—homeward, rearward, backward.
y, as—mighty, stormy, windy.

Geography.

1. How should you explain the following passage to a class, which had read it as part of a reading lesson? Draw out fully the points to be explained.

'The Cotswolds, though not very high, fill an important place. They are the chief water-parting of Southern England; for they lie between the two chief river-basins, those of the Severn and the Thames. From these, in tracing the boundaries of the *Eastern* section of England, we proceed over the north-eastern shoulder of the central table-land, pass between the Avon and the Welland, the Trent and the Witham, and end on the eastern side of the Lincolnshire Wolds.'

Use the map after reading through the piece, to show the position of mountains and rivers mentioned. Then draw *map* and *section* on blackboard. Explain, or elicit if already known, the meaning of *water-parting*, *river-basins*, and *shoulder of table-land*.

A *water parting* is the high land which divides the land drained by different rivers. (Illus. roof of a house.) A *river-basin*, the whole of the land drained by a river and its tributaries. (Illus. from district if suitable; if not, the collection of the water from different parts of the roof of a house.) *Shoulder of table-land*, the highest part of the rising ground before the table-land or elevated plain is reached. (Illus., any hill, if one in neighbourhood.) Eastern section of England:—Eastern division.

2. Describe the journey of a traveller, starting from Adelaide, following the course of the Murray or the Darling, reaching Sydney by land, and returning to Adelaide by sea.
Illustrate your answer by a map.
Insert the lines of latitude and longitude.

Leaving Adelaide, the capital of South Australia and a fine thriving city of 40,000 inhabitants, a steamer sailing southwards would pass Kangaroo Island, and enter Encounter Bay. Then sailing northwards it would pass through Lake Alexandrina. Two hundred miles from the mouth of the river, a sudden turn to the east would be made, and 400 miles further from the coast, the junction of the Murray and Darling would be reached. Nearly the whole course of the Murray (2400 miles) is navigable. Leaving the Murray for the Lachlan, the steamer would reach within 300 miles of Bathurst, a town of 20,000 inhabitants, noted for its copper mines.

Sydney would be reached by land. This town is situated on Port Jackson, one of the finest harbours in the world, and has a population of nearly a quarter of a million. Taking steamer again, a traveller would sail southwards, along the coast of New South Wales to Cape Howe, then westwards, through Bass' Strait, past the entrance to Port Philip, on which stands Melbourne, capital of Victoria, and the largest city in Australia. The whole of the coast of Victoria would be skirted, and after a north-westerly course from Cape Otway, St. Vincent Gulf, and Adelaide, would again be reached. The whole distance travelled would be upwards of 5000 miles.

History.

1. How often did Julius Cæsar invade this country, and in what years?

Julius Cæsar invaded this country twice:—
First, in 55 B.C., when he ravaged the southern counties, defeated the British in two battles, took hostages, and then returned to Gaul. *Second*, in 54 B.C., when he again defeated the Britons under Cassivelaunus, settled the amount of tribute to be paid, took hostages, and retired to Gaul.

2. Some writers called Egbert the first King of England, and others give that title to Athelstan; which would you say, and on what grounds?

Although Egbert gained paramount authority over the other Saxon kings (Kent, East Anglia, and Northumbria,) his authority was very often disputed or despised. He never styled himself 'King of England,' but was contented with the titles of 'King of Wessex' and 'Bretwalda.' On the other hand Athelstan may be said to have reigned with undisputed sway after the battle of Brunanburgh. He also styled himself 'King of the Anglo-Saxons,' and 'King of the English.'
For these reasons, I should give the title to Athelstan.

3. Whom did Ethelred the Unready marry, and how did he treat the Danes? Trace some of the consequences of the two events.

Ethelred married Emma, sister of Richard II., of Normandy. He attempted to buy off the hostility of the Danes by presents of money. Year by year, however, they came in greater numbers, till, in 1002, he resolved on their massacre. In many places they were all destroyed. Among others, Gunhilda, sister of the King of Denmark, was killed. To revenge her death, Sweyn came over to England, and Ethelred was compelled to flee to Normandy, a refuge having been provided for him by his father-in-law. Ethelred returned after the death of Sweyn, taking with him many Normans, who were thus introduced into Britain. The connection became more intimate between the two courts till England was eventually invaded from Normandy by William the Conqueror.

Composition.

Write from memory the substance of the passage read to you by the Inspector.

Just as we were leaving our post of observation in despair, the sharp, distinct snap of a bough in the forest at our backs set our hearts beating. Everything was still and motionless for ten minutes more, when, about 200 yards below us, moving slowly and silently as a shadow, we made out a huge brown form looking twice its real size in the dim light. The mysterious way in which the bear appears straight from the dark recesses of the woods or the distant peaks, where he has been keeping out of sight all day; his slow, solemn movements, and the absolute silence he keeps, makes him different from all other beasts. The boar cannot help grunting out his satisfaction, or holding converse with his kind; the wolf and jackal make night hideous with their howlings; every other beast is more or less noisy, but Bruin alone steps out of the darkness, silent as a shadow, to return as noiselessly as he came.

Needlework.

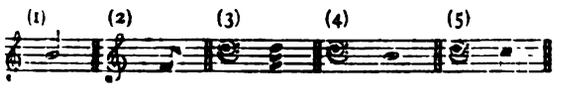
FEMALES.

One hour will be allowed for this exercise.

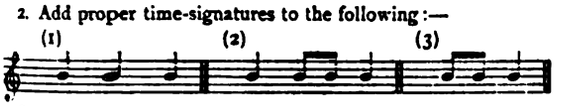
Music.

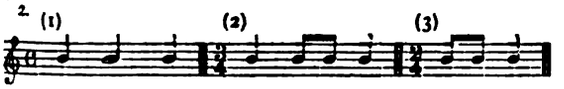
A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

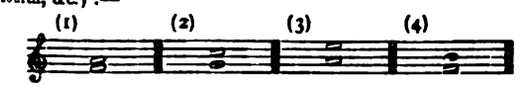
1. Write above each of the following notes its pitch-name (C, D), and below write the signs for rests corresponding in value to the notes :—

1. (1) B (2) F (3) F (4) D (5) E

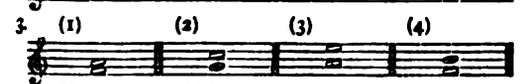
2. Add proper time-signatures to the following :—



2. 

3. Write below each of the following intervals its name (major fourth, &c.) :—



3. 

Major 3rd. Major or Perfect 4th. Major or Perfect 5th. Pluperfect 4th or Tritone.

TONIC SOL-FA NOTATION.

1. Write a four-pulse tone, using two-pulse measure.

1. |d :— |— :— ‖

2. Write the names of the following intervals :—(1) *fah* to *lah*; (2) *soh* to *doh*^{1}; (3) *lah* to *me*^{1}; (4) *fah* to *te*.

2. (1) Major 3rd; (2) Perfect 4th; (3) Perfect 5th; (4) Pluperfect 4th or Tritone.

3. Write the following an octave lower, and state what is meant by the direction Key F :—

Key F.

m^1 r^1 d^1 t r^1 l s t d^1

3. Key F.

m r d t$_1$ r l$_1$ s$_1$ t$_1$ d

"Key F" means that the Tonic or key-note of the scale is F. The sound of F in the scale must be found and called *Doh*.

SECOND YEAR.

Pupil Teachers at end of Second Year.

FIRST PAPER.

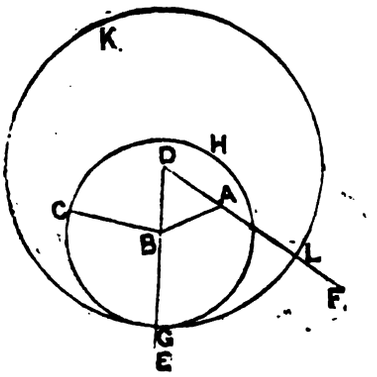
Three hours and a half allowed for this Paper.

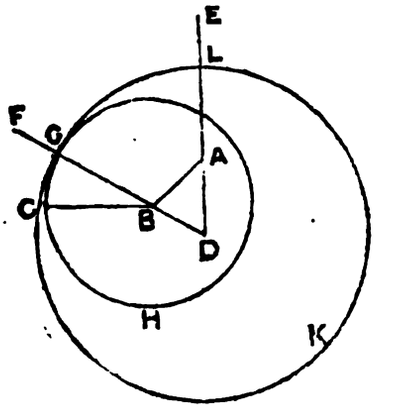
Euclid.

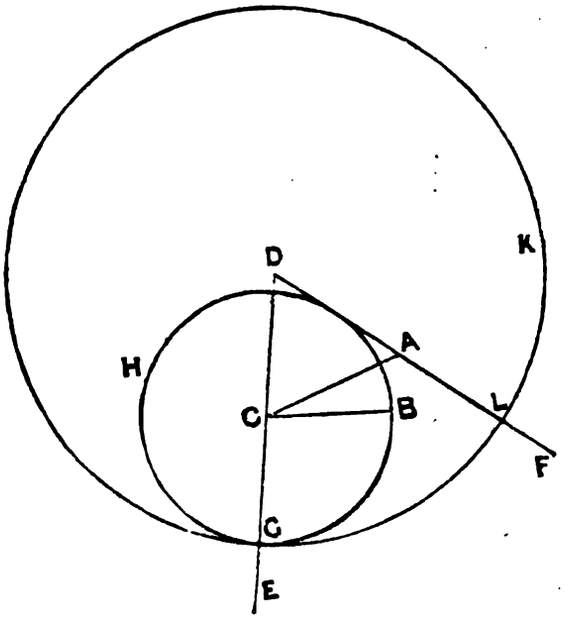
MALES.

[All generally understood abbreviations for *words* may be used.]

1. From a given point, to draw a straight line equal to a given straight line. When the given point is neither in the line







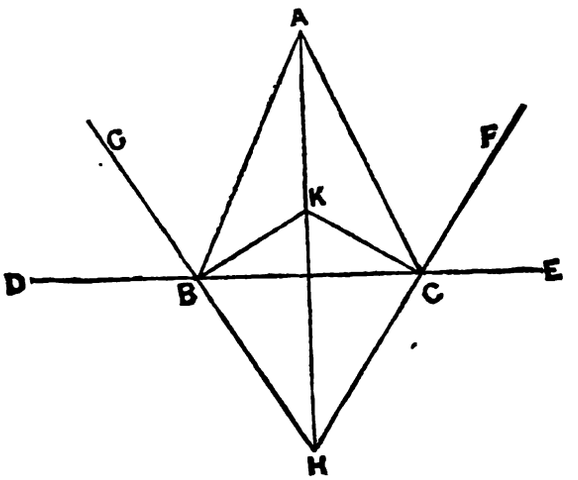
nor in the line produced, show by diagrams that there are several ways in which the line may be drawn.

Prop. 2, Bk. I.

2. If from the ends of a side of a triangle there be drawn two straight lines to a point within the triangle, these shall be less than the other two sides of the triangle, but shall contain a greater angle.

Prop. 21, Bk. I.

3. Show that the vertex of an isosceles triangle and the intersections of the bisectors of the interior and exterior angles at the base are in the same straight line.



In the isosceles triangle ABC let the exterior ∠'s be bisected by FC and GB, which produced intersect in H, and the interior ∠'s be bisected by BK and CK intersecting in K. Join AK, KH. Then AK, KH are in the same straight line.

The ∠'s ACE, ACB=2 right ∠'s, and the ∠'s ABC, ABD=2 right ∠'s. And ACB=ABC (I. 5.)

∴ ACE=ABD

And halves of=things are=. ∴ ∠ FCE= ∠ GBD

∴ ∠ HBC= ∠ HCB (I. 15) ∴ HB=HC (I. 6)

And BK=KC (I.6) ∴ ∠ HKB= ∠ HKC.

And ∠ BKA= ∠ CKA (I. 8). ∴ ∠'s HKB, BKA= ∠'s HKC, CKA. And ∴ ∠'s HKB, BKA=2 right ∠'s.

∴ HK, KA are in the same straight line (I. 14).

Q. E. D.

Arithmetic.

FEMALES.

1. What fraction must be added to $2\frac{1}{2}$, $1\frac{3}{7}$, $3\frac{5}{12}$ to make a sum total of 8?

$$\text{Fraction required} = 8 - (2\tfrac{1}{2} + 1\tfrac{3}{7} + 3\tfrac{5}{12})$$
$$= 8 - \left(6\frac{28+36+35}{84}\right)$$
$$= 8 - 7\tfrac{19}{21}$$
$$= \underline{\tfrac{2}{21}}. \text{ Ans.}$$

2. A man buys $\frac{3}{5}$ of a ship's cargo for £2535 10s. 0d. How much of the ship could be bought for £3688?

£ s. £

2535 10 : 3688 :: $\frac{3}{5}$: x

$x = \frac{5}{10151} \times \frac{36880}{1} \times \frac{3}{5}$

$= \underline{\tfrac{552}{821}}$. Ans.

3. Reduce to decimals $1\frac{3}{16}$ of $5\frac{5}{12}$ and $\frac{2\frac{2}{9}}{3\frac{3}{4}}$.

$1\frac{3}{16}$ of $5\frac{5}{12}$

$= \frac{19}{16} \times \frac{65}{12}$

$= \frac{1235}{192}$

$= \underline{6{\cdot}25}$. Ans.

$\frac{2\frac{2}{9}}{3\frac{3}{4}} = \frac{20}{9} \times \frac{4}{15}$

$= \frac{16}{27}$

$= \underline{{\cdot}592}$. Ans.

4. Add together $1\frac{3}{4}$ weeks, $2\frac{1}{2}$ days, $\frac{4}{5}$ of an hour, $10\frac{1}{2}$ minutes, and 33 seconds.

	wk.	dys.	hrs.	mins.	secs.
$1\frac{3}{4}$ wks. =	1	4	4	48	0
$2\frac{1}{2}$ dys. =		2	18	0	0
$\frac{4}{5}$ hr. =				42	$51\frac{3}{7}$
$10\frac{1}{2}$ mins. =				10	40
33 secs. =					33
	1	6	23	42	$4\frac{3}{7}$. Ans.

Grammar.

MALES AND FEMALES.

1. It is good in discourse, and *speech* of conversation, to vary and *intermingle* speech of the present occasion with arguments; tales with reasons; *asking of questions with telling of opinions;* and *jest* with earnest. (*Bacon's Essays.*)

2. Analyse the above, parsing the words in italics.

3. Point out, and explain, all the Latin prefixes in the above.

(1) ANALYSIS.

Sentence.	Kind.	Subject.	Predicate.	Object.	Extension.
(*a*) It is good in discourse and speech of conversation to vary and intermingle speech of the present occasion with arguments.	Principal Sent.	It, to vary and intermingle speech of the present occasion with arguments in discourse and speech of conversation.	is good		
(*b*) Tales with reasons	P. S. contracted	[It, to intermingle] tales with reason	[is good]		
(*c*) Asking of questions with telling of opinions	P. S. contracted	[It, to intermingle] asking of questions with telling of opinions	[is good]		
(*d*) And jest with earnest	P. S. contracted	[It, to intermingle] jest with earnest	[is good]		

PARSING.

speech—abs. noun, neut., sing., obj., gov. by 'in' und.

intermingle—reg. trans. verb, inf., pres., used as abs. noun, neut., sing., nom. to 'is,' in apposition with 'it.'

asking—pres. part. of 'to ask,' used as verbal or abs. noun, neut., sing., obj., gov. by 'to intermingle.'

of—prep., showing relation between 'asking' and 'questions.'

questions—com. noun., neut., plural, obj., gov. by 'of.'

with—prep., showing relation between 'asking' and 'telling.'

telling—pres. part. of 'to tell,' used as verbal or abs. noun, neut., sing., obj., gov. by 'with.'

of—prep., showing relation between 'opinions' and 'telling.'

opinions—com. noun, neut., plural, obj., gov. by 'of.'

jest—abs. noun, neut., sing., obj., gov. by 'to intermingle.'

(2) *dis*—meaning *to and fro.* Discourse is that speech which passes from one to another.

con—meaning *together;* conversation is talk in which words are turned over together.

inter—meaning *among;* intermingle, to mix up together.

pre—meaning *before;* present—to be before, at this time; now.

oc—meaning *in the way of,* occasion—that which happens or falls in the way; an opportunity.

4. Paraphrase the following lines:—

Silence is the perfectest herald of joy;
I were but little happy could I say how much.

Excess of joy is most surely shown in the absence of all desire for speech. I should have but a small amount of happiness if I were able to say how happy I am.

Geography.

Answer two Questions.

1. Describe the sources, and the upper portions of the courses, of the rivers rising in the Alps.

Illustrate your answer by a map, or by little sketch-maps, tracing each river till it reaches really level country.

Insert the lines of latitude and longitude.

The two largest rivers rising in the Alps are the Rhine and the Rhone. Other rivers are the Inn, a tributary of the Danube, the Ticino, tributary of Po, and the Aar, tributary of the Rhine.

The Rhine is formed by the union of the Vorder Rhine from a glacier on Mt. St. Gothard, and the Hinter Rhine from Vogelberg, 7000 feet above the sea. After this junction it flows north to the Lake Constance, and emerges at the northern extremity to take a westerly course. At Schaffhausen it falls nearly 80 feet, and makes a still further descent of other 240 feet before it reaches Basel. It is at this place still 755 feet above the sea. Its volume is increased by the tributaries Neckar, Maine, Aar, Lippe, and Moselle. Near Mayence it passes through a mountain gorge, and then broadens into the slow stream of the Netherlands.

The Rhone also rises on St. Gothard. It drains the valley between the main chain of the Alps on the S. and the Bernese Alps on the N. It flows through the Lake Geneva after having fallen nearly 4000 feet from its source to the lake. Up to this point it has flowed in a westerly direction, but at Lyons it reaches a comparatively level country, and flows south into the Mediterranean.

2. Describe the physical character of Southern India.

N.B.—*Do not give a mere string of names, but try to give a clear general view of the country as a whole, introducing the important names as parts of your description.*

Southern India is triangular in shape, the apex pointing to the south. It may be said to be bounded on the north by the rivers Tapty and Mahanuddy. From the basins of these two rivers the land gradually rises till it reaches a height of 3000 feet. It then forms a great table-land, flanked by the Eastern and Western Ghauts, which meet together in the south, the united range going under the name of the Neilgherry Mountains. Between the Western Ghauts and the sea there is a fertile plain of about 40 miles in width. A similar plain but of greater breadth stretches between the Eastern Ghauts and the Bay of Bengal. The Western Ghauts are much higher than the Eastern Ghauts, and present an unbroken front to the coastward plain. Through gaps in the eastern chain, several rivers (Godavery, Kistnah, Pennair, and Cauvery) find their way to the sea. South of the Neilgherries is a great break, called the Gap of Coimbatore, beyond which the chain rises again and ends in the lofty Cape Comorin.

3. Supposing a vessel to be coming from Australasia to England, and to have brought articles of trade from each of the colonies; write an account of the whole cargo, describing where and how each part of it was procured.

Starting from Brisbane, the capital of Queensland, a vessel would bring wool, wine, cotton, and fruits from the great plains of that colony. Calling at Sydney it would add to its cargo, gold and copper, as well as more wine and wool. To these would be added, tallow and skins and more gold and wool at Melbourne.

South Australia is the best wheat-growing district, and the products of its fields, its flocks, and its vineyards would increase the lading of the ship at Geelong; while Tasmania would add whale oil and spermaceti from the great Antarctic seas. Oil and wood of different kinds as well as wool from Western Australia would complete the lading of the vessel.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination papers.

Arithmetic.

MALES.

1. In a school of 80 scholars, open 10 half days a week, the average attendance is 72, but the average of the 70 most regular scholars is 68; how many half days on an average do the other, 10 scholars attend?

Total No. of attendances $= 72 \times 10 = 720$
„ made by 70 reg. scholars $= 68 \times 10 = 680$
„ made by 10 irreg. scholars $= 40$
∴ Average attend. made by ditto $= 40 \div 10 = \underline{4}$. Ans.

2. At what rate per cent. per annum simple interest will £765 amount to £872 2s. in 4 years?

Int. for 4 yrs. $=$ £872 2s. $-$ £765
$=$ £107 2s.
∴ Int. for 1 yr. $=$ £107 2s. $\div 4$
$=$ £26 15s. 6d.

£ £ £
765 : 100 :: $26\frac{31}{40}$: Rate per cent.
$= \frac{1}{765} \times \frac{100}{1} \times \frac{1071}{40}$
$= \underline{3\frac{1}{2}}$. Ans.

3. If a sovereign be worth 25 francs 15 centimes, what per cent. does a man lose in getting only 25 francs for a sovereign?

c.
Loss on 25 fr. 15 c. $= 15$
„ 1 „ $= \frac{15}{2515}$
„ 100 „ $= \frac{15 \times 100}{2515}$
$= \underline{\frac{300}{503}}$. Ans.

4. An army of 8000 men has rations for 25 days, but after 5 days it receives reinforcement, and the rations are consumed in 21 instead of 25 days; how many men were in the reinforcement?

If there had been no reinforcement the
provisions would have lasted $25 - 5 = 20$ days.
They actually last $21 - 5 = 16$ „ days
No. of men to eat provisions in 20 $= 8000$
„ „ „ $1 = 8000 \times 20$
„ „ „ $16 = \frac{8000 \times 20}{16}$
$= \underline{10{,}000 \text{ men.}}$

∴ Reinforcement $= 10{,}000 - 8000 = \underline{2000 \text{ men.}}$ Ans.

History.

MALES AND FEMALES.

1. Contrast the condition of the Norman and Saxon inhabitants of this country under William I. How long did this strife of races continue?

The Normans occupied all the places of trust and power. They were allowed to build castles, and overrun the country round about. These castles were a source of great trouble to the Saxons. The language of the courts of law and the church was Norman. The Normans despised their Saxon neighbours, treating them with great indignity. The Saxons were in most instances little better than serfs. They were treated with cruelty. Their clothing was coarse and contrasted very unfavourably with that of the Normans. They were forbidden under severe penalties to kill game, mutilation being the punishment. They were not permitted to assemble in numbers together. Their condition was in every way inferior to that of the Normans.

2. How did Henry II. gain the throne? Tell what you know about his wife.

Henry II. was the grandson of Henry I., at whose death the nobles promised fealty to Maud. This faith was broken by Stephen, grandson of the Conqueror, taking possession of the throne. Many attempts were made by Maud to gain possession of the throne, but with little success. Her son Henry, however, became Duke of Normandy, and came over to England to claim the throne. He gained some slight advantage over Stephen, but the nobles arranged a treaty, by which he was to become king after Stephen's death. By virtue of that treaty, he ascended the throne in 1154.

Henry married Eleanor, the divorced wife of Louis VII., of France. Their private life was unhappy. Henry had several natural children, and his wife is said to have poisoned 'Fair Rosamond,' one of his favourites.

3. Give the dates of our six kings styled Edward, and describe the character and fortunes of one of them.

Edward I., 1272-1307; II., 1307-1327; III., 1327-1377; IV., 1461-1483; V., 1483; VI., 1547-1553.

Edward the First was the greatest of the Plantagenet kings. He was energetic, industrious, and impartial. He carefully administered the laws, and made in them many improvements. He was proud and haughty, but confirmed the privileges of the people by renewing the Charter. His ambition led him to fight against both Wales and Scotland, treating his enemies with great cruelty. He began active life by fighting against the Saracens. Near Nazareth, he was shot by a poisoned arrow. On his father's death, he succeeded to the crown, took possession of Guienne, and almost immediately invaded Wales, which he subdued, making his son Prince of Wales.

The throne of Scotland was claimed by several persons, and Edward was asked to arbitrate between them. He claimed to be *overlord*, and gave the throne to Baliol. Baliol rebelled, and Edward invaded Scotland, defeating the Scots at Dunbar. After several Scotch victories under Wallace, Edward completed their overthrow at Falkirk; but while the affairs of Scotland were being considered in London, Bruce, now heir to the throne, drove the English from Scotland. On his way to punish Bruce, Edward died at Burgh-on-the-Sands, near Carlisle in 1307.

Teaching.

How may mental arithmetic be made interesting to young children?

In order to make mental arithmetic interesting to young children, it will be necessary that the questions which are asked should come well within their grasp, that they should appeal to their sympathies, and that they should deal almost absolutely with concrete subjects pertaining to their everyday life.

Questions about their play, their marbles, their games, the errands they run for their parents, the pages they read, the spellings they learn, and their home duties, always appeal to their feelings, and bright eyes invariably are seen where such questions are asked.

Taking places, where it can be done without noise or bustle, adds to the interest of a mental arithmetic lesson.

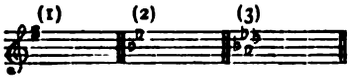
Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write the key-signatures of each of the following major keys:—(1) of G; (2) of B♭; (3) of A♭.

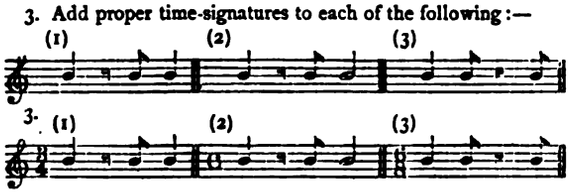
1. (1) (2) (3)



2. Write below each of the following intervals its name (major second &c.):—

2. (1) (2) (3) (4)

Perfect 5th. Augmented 4th or Tritone. Imperfect 5th. Perfect 5th.

3. Add proper time-signatures to each of the following:—

3. (1) (2) (3)

TONIC SOL-FA NOTATION.

1. Write the names of the following intervals:—(1) *lah*, to *me*; (2) *fah* to *te*; (3) *te*, to *fah*; (4) *fah* to *doh*^{1}.

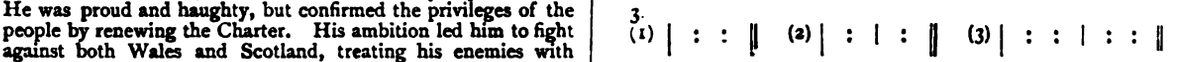
1. (1) Perfect 5th; (2) Pluperfect 4th or Tritone; (3) Imperfect 5th; (4) Perfect 5th.

2. Which tones of the scale have the strongest leaning tendency?

2. *Te*; *fah*.

3. Write (1) a three-pulse measure; (2) a four-pulse measure; and (3) a six-pulse measure.

3.



(1) (2) (3)

THIRD YEAR.

Pupil Teachers at end of Third Year.

FIRST PAPER.

Three hours and a half allowed.

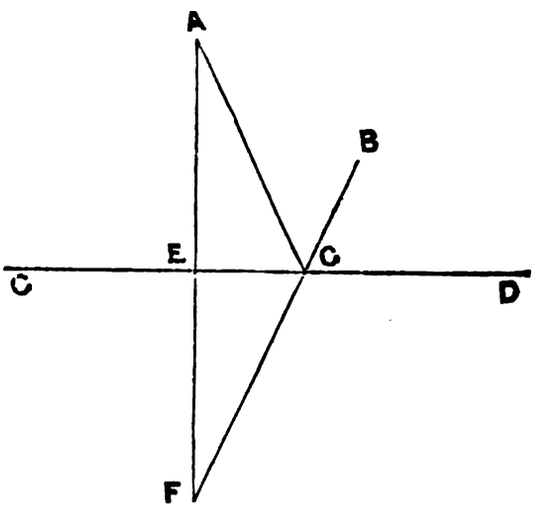
Euclid.

[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including Question 1, *if you can.*

MALES.

1. From two given points on the same side of a given line, draw two lines which shall meet in that line and make equal angles with it.



Let A, B be the given points, and CD be the given line.

From A let fall AE perpendicular to CD, and produce AE to F, making EF=AE. Join F, B, cutting CD in G. Join A, G. AG and BG shall be the lines required.

Because AE, EG=FE, EG, and ∠GEF=∠GEA (const.)

∴ ∠AGE=∠FGE (I. 4.)

And ∠EGF=∠BGD (I. 15)

∴ ∠AGE=∠BGD. Q. E. F.

2. If two triangles have two sides of the one equal to two sides of the other, each to each, but the base of one greater than the base of the other; the angle contained by the sides of the one which has the greater base, shall be greater than the angle contained by the sides, equal to them, of the other.

Prop. 25, Bk. I.

3. To describe a parallelogram equal to a given rectilineal figure, and having an angle equal to a given rectilineal angle.

Prop. 45, Bk. I.

Algebra.

Answer two Questions.

1. If $a=5, b=7$, find the value of $6\sqrt{6(b^2-a^2)} - 7\sqrt[3]{12(a+b)^2}$;

also of $\dfrac{a^3-5ab+6b^2}{a-3b} - \dfrac{4(a^3-b^3)}{a^2+ab+b^2}$

(a) $6\sqrt{6(b^2-a^2)} - 7\sqrt[3]{12(a+b)^2}$

$=6\sqrt{6(49-25)} - 7\sqrt[3]{12(5+7)^2}$

$=6\sqrt{144} \quad -7\sqrt[3]{12^3}$

$=(6\times 12) \quad -(7\times 12)$

$=-12.$ Ans.

(b) $\dfrac{a^2-5ab+6b^2}{a-3b} - \dfrac{4(a^3-b^3)}{a^2+ab+b^2}$

$=\dfrac{(a-3b)(a-2b)}{a-3b} - \dfrac{4(a^2+ab+b^2)(a-b)}{a^2+ab+b^2}$

$=(a-2b) \quad -4(a-b)$

$=(5-14) \quad -4(5-7)$

$=-9+8$

$=-1.$ Ans.

2. What is the objection to the following?—Let $a=1$, then $a^2=1$ or $a^2-1=0$ $\therefore$ (dividing by $a-1$) $a+1=0$ $\therefore$ $a=-1$ $\therefore$ $+1=-1$.

Solve the equation :—

$$\frac{x+1}{6}+\frac{3x-1}{8}-\frac{5x-7}{12}+1=\frac{7x-5}{24}$$

The objection lies in dividing by $a-1$. Since $a=1$ $\therefore$ $a-1=0$. Hence the objection.

$$\frac{x+1}{6}+\frac{3x-1}{8}-\frac{5x-7}{12}+1=\frac{7x-5}{24}$$

Mult. by 24.

$4x+4+9x-3-10x+14+24=7x-5$;

Collecting, we have

$4x=44$

$x=11.$ Ans.

3. If $\dfrac{a}{b}=\dfrac{c}{d}$, show that $\dfrac{a+b}{a-b}=\dfrac{c+d}{c-d}$

Simplify $\dfrac{\dfrac{a}{b}+\dfrac{b}{a+b}}{a^2-ab+b^2-\dfrac{2b^3}{a+b}}$

(a) $\dfrac{a}{b}=\dfrac{c}{d}$ $\quad\therefore \dfrac{a}{b}+1=\dfrac{c}{d}+1$

$\therefore \dfrac{a+b}{b}=\dfrac{c+d}{d}$

$\dfrac{a}{b}=\dfrac{c}{d}$ $\quad\therefore \dfrac{a}{b}-1=\dfrac{c}{d}-1$

$\therefore \dfrac{a-b}{b}=\dfrac{c-d}{d}$

But $\dfrac{a+b}{b}=\dfrac{c+d}{d}$

$\therefore \dfrac{\dfrac{a+b}{b}}{\dfrac{a-b}{b}}=\dfrac{\dfrac{c+d}{d}}{\dfrac{c-d}{d}}$

$\therefore \dfrac{a+b}{a-b}=\dfrac{c+d}{c-d}$ Ans.

(b) Simplify $\dfrac{\dfrac{a}{b}+\dfrac{b}{a+b}}{a^2-ab+b^2-\dfrac{2b^3}{a+b}}$

$$=\frac{\dfrac{a(a+b)+b^2}{b(a+b)}}{\dfrac{(a+b)(a^2-ab+b^2)-2b^3}{a+b}}$$

$$=\frac{\dfrac{a^2+ab+b^2}{b(a+b)}}{\dfrac{a^3+b^3-2b^3}{a+b}}$$

$$=\frac{\dfrac{a^2+ab+b^2}{b}}{\dfrac{a^3-b^3}{1}}$$

$$=\frac{1}{b(a-b)}$$ Ans.

Mensuration.

A footpath goes along two adjacent sides of a rectangular field, 196 and 147 yards long. What distance would be saved if the path were made along the diagonal?

$\sqrt{(196)^2+(147)^2}$

$=\sqrt{38416+21609}$

$=\sqrt{60025}$

$=245$ Length of diagonal.

Distance saved $=(196+147)-245$

$=343-245$

$=98$ yards. Ans.

Arithmetic.

FEMALES.

1. Divide 6·817 by ·0017, and multiply the quotient by $\frac{3}{16}$ of ·00012525.

·0017)6·8170(4010·

68

·17

17

·0

$\frac{3}{16}$ of ·00012525

$=3\times$ ·00000501

$=$ ·00001503

4010· × ·00001503

$=$ ·0602703. Ans.

2. A person spends $\frac{1}{8}$ of his income on rent and taxes; ·35 on household expenses; and $\frac{1}{4}$ on other things. He has then £225 10s. 0d. saved every year; what is his annual income?

Fraction left $=1-(\frac{1}{8}+\cdot 35+\frac{1}{4})$

$=1-(\cdot 125+\cdot 35+\cdot 25)$

$=\cdot 275$

$\therefore$ ·275 : 1 :: £225·5 : Annual income.

$=$£820. Ans.

3. A scuttle of coal is charged 2d. when coals are 27s. a ton; how much ought the scuttle to hold?

s. d. ton

27 : 2 :: 1 : x

$\therefore x=2240\times 2\div 324$

$=13\frac{11}{18}$lbs. Ans.

4. Divide 100 into two parts, such that the one may exceed the other by 8·75.

Both Nos. are equal after 8·75 has been taken away.

$\therefore$ Lesser No. $\dfrac{100-8\cdot 75}{2}=45\cdot 625.$ Ans.

And greater No. $=45\cdot 625+8\cdot 75=54\ 375.$ Ans.

Grammar.

MALES AND FEMALES.

1. Every *one who* has *undertaken* to instruct others can *tell what* slow *advances* he has been *able* to make, and *how much* patience it requires to recall vagrant *inattention*, to stimulate sluggish indifference, and to rectify absurd misapprehension.

Analyse the above, parsing the words in italics.

2. Point out in this passage, (*a*) Latin prefixes.
(*b*) English prefixes.
(*c*) Latin affixes.
(*d*) any English affix.
(*e*) any double prefix.

3. Paraphrase the passage.

(1) ANALYSIS.

Sentence.	Kind.	Connective.	Subject.	Predicate.	Object.
(*a*)					
Every one can tell	Princ. Sent.		Every one	can tell	[Noun Sent.]
(*b*)					
Who has undertaken to instruct others	Adj. S. to *a*	In rel.	who	has undertaken	to instruct others
(*c*)					
What slow advances he has been able to make	Noun S. Obj. to *a*	In rel.	he	has been able to make what slow advances	
(*d*)					
And [he can tell]	Prin. S. co-ord. to *a*	and	[he]	[can tell]	
(*e*)					
How much patience it requires to recall vagrant inattention.	Noun S. to *d*	and	it, to recall vagrant inattention	requires	how much patience
(*f*)					
To stimulate sluggish indifference	Noun S. to *d*		To stimulate sluggish indifference	[requires]	[how much patience]
(*g*)					
And to rectify absurd misapprehension	Noun S. to *d*	and	to rectify absurd misapprehension	[requires]	[how much patience]

PARSING.

One—indef. pers. pro., masc. (or fem.), sing., 3rd, nom. to 'can tell.'
who—rel. pro., masc. (or fem.), sing., 3rd, nom. to 'has undertaken,' and agreeing with its antecedent 'who.'
undertaken—past part. of 'to undertake,' referring to 'who.'
tell—irreg. trans. verb, infin., pres., gov. by 'can,' forming with can, irreg. trans. verb, act., pot., pres., 3rd, sing., agreeing with its nom. 'one.'
what—rel. pro., used as adj., qual. 'advances.'
advances—com. noun, neut., plur., 3rd, obj., gov. by 'tell.'
able—adj. of quality, qualifying 'he.'
how—adv. of deg., qualifying 'much.'
much—adj. of quantity, qualifying 'patience.'
inattention—abs. noun, neut., sing., 3rd, obj., gov. by 'to recall.'

(2) Latin prefixes:— in-, ad-, at-, in-, dif-, ab-.
English ,, under-, mis-.
Latin affixes:— -tion, -ence, -sion, -ate.
English affix:— -ish.
Double prefixes:—inat- (L.), misap- (E. and L.), indif- (L.)

(3) All those persons who have attempted to teach others, are able to tell of the little progress they have been able to make, and what a great amount of endurance it needs in trying to refix the mind upon study after it has wandered, to rouse the slow and careless, and to put right ideas into the mind when once wrong ones have taken their place there.

4. What should you infer as to the origin of nouns which form their plural by a vowel change?

That the words were of Saxon origin. Many old English words formed their plurals by the addition of a syllable, which was nearly always accompanied by a change of the vowel sounds. In modern English the syllable has been lost, and the change of vowel sound remains.

Geography.

(Answer two Questions, including *one* map.)

1. Draw a full map, showing Burmah, Siam, and the islands of the Indian Archipelago.

N.B.—Insert the lines of latitude and longitude.

2. Describe the physical character of Southern India, giving a clear general view of the country, as a whole.

N.B.—*If you like*, instead of the map in Q. 1, you may draw a map in illustration of this answer. Insert the lines of latitude and longitude.

For answer to Question 2, refer to answer No. 2 in Second Year Questions in Geography.

3. What is an ocean current? Explain the causes of them, and give examples.

An ocean current is a movement of the waters of one part of the ocean to another. Currents depend primarily upon the unequal densities and temperatures of different parts of the ocean. Lighter waters ascend; colder waters descend, and where evaporation takes place, other waters flow towards that place to make up the deficiency. There is always a current setting in from the equator to the poles, and a counter current setting in from the poles to the equator. These two currents, however, are greatly modified in their direction by the configuration of the land, by the wind, and by other local causes. The principal currents of the Atlantic are the Equatorial and the Arctic, modified into the Gulf Stream, the Brazil, and the Guiana currents. In the Pacific, owing to its greater expanse, the currents are not so strongly marked, but there are, as in the Atlantic, the Equatorial and Polar Currents, with modifications of them in the Peruvian, New South Wales, Japan, and the counter currents.

In the Indian Ocean the Equatorial becomes the Mozambique current.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination papers.

Arithmetic.

MALES.

1. Show that $\sqrt{\frac{(\cdot185)^2-(\cdot148)^2}{\cdot0175\times\cdot001575}}=21\frac{1}{7}$.

$$\sqrt{\frac{(\cdot185)^2-(\cdot148)^2}{\cdot0175\times\cdot001575}}=\sqrt{\frac{\cdot034225-\cdot021904}{\cdot0000275625}}$$
$$=\frac{\cdot111}{\cdot00525}$$
$$=21\cdot142857$$
$$=21\tfrac{1}{7}.$$

2. If a grocer paid £10 6s. 3d. for $5\frac{1}{2}$ cwt. of sugar, how must he sell it per lb. to gain 12 per cent.?

$$\frac{£10\ 6s.\ 3d.}{5\frac{1}{2}\times112}=\frac{2475}{616}\text{ cost price per lb. in pence.}$$

As 100 : 112 :: $\frac{2475}{616}$: Selling price

$$=\frac{2475\times112}{616\times100}$$
$$=4\tfrac{1}{2}\text{d. Ans.}$$

3. If the wages of men and boys are as 5 : 2, and 5 men and 4 boys earn £14 17s. in 12 days, find the wages of each per day.

Wages of 1 man $=\frac{2}{5}$ of a boy
,, ,, 5 men $=\frac{2}{5}\times5=2\frac{1}{2}$
,, ,, 5 men + 4 boys $=2\frac{1}{2}+4=16\frac{1}{2}$
∴ Wages of a boy per day $=\frac{£14\ 17s.}{16\frac{1}{2}\times12}$
$=1s.\ 6d.$
And ,, ,, man $=\frac{5}{2}$ of 1s. 6d.
$=3s.\ 9d.$ Ans.

4. If I get £36 dividend from investing £1100 in $4\frac{1}{2}$ per cent. stock, what is the price of the stock? (Omit brokerage.)

£36 is obtained from £1100
1 ,, ,, $\frac{1100}{36}$
$4\frac{1}{2}$,, ,, $\frac{1100\times4\frac{1}{2}}{36}$
$=137\frac{1}{2}$. Ans.

History.

MALES AND FEMALES.

1. Give in a table the names, dates, and relationship of our Stuart sovereigns from Mary of Scotland to Queen Anne.

Mary Queen of Scots.
|
James I. (1603-1625) son.
|
Charles I. (1625-1649) son.
|
Charles II. (1660-1685) son. James II. (1685-1688) brother.
|
Mary II. (1688-1694) daughter. Anne (1702-1714) sister.
marr. William III. (1688-1702) son-in-law.

2. What was the Long Parliament? Mention remarkable events attending its course and end.

The Long Parliament was a parliament called in 1639 by Charles I. for the purpose of raising money to continue the war against the Scots, who had rebelled against the introduction of the Liturgy into Scotland. It began its work by the impeachment of Strafford and Laud, and during its continuance the Courts of Star Chamber and High Commission were abolished, and the Grand Remonstrance to Charles was agreed upon; Charles broke its privileges by going to the House to seize some of its members, and the Civil War was determined upon and carried out by it. Those of its members who were opposed to the tactics of Cromwell were driven out, and eventually the remainder (the Rump) were driven out by Cromwell. It was recalled by the malcontent officers during Richard Cromwell's protectorate, but again dismissed. Then it was recalled by General Monk; and, after issuing writs for a new election, it dismissed itself after an existence of twenty years.

3. 'The social condition of England for the first few years of the peace of 1815 was wretched in the present and full of anxiety for the future.' Explain how the conclusion of a great war had such effects.

The National Debt of England was more than trebled by the war; and the whole of Europe was impoverished by it also. That being the case, there was no demand for British products abroad, and, consequently, little or no demand for labour at home. With a view of encouraging home trade and agriculture, the Corn Laws were passed, and this had the effect of raising the price of bread when there was less money to pay for it. The consequence was that large bands of workmen were unemployed. A scarcity of food occurred in 1816, and riots of different kinds took place in different parts of the country. Distress and discontent were rife, and political and other societies plotted revolution as well as demanded reforms. These events, while showing the wretchedness of the people in the present, augured ill for the happiness of the future.

Teaching.

Write out notes of a lesson on 'Mood.'

Introduction.—Write on blackboard any sentences showing the different uses of the same verb by means of inflexions or auxiliaries. From these sentences elicit the fact that *a verb may be used in several ways indicating a difference of meaning.*

The word used to show the mode in which the verb is used is '*Mood.*'

Definition.—To be written and committed to memory.—'Mood is that inflexion which a verb undergoes to show the mode or manner in which the action or state denoted by the action is presented to the mind.'

Kinds of Moods.—As far as possible get the distinction made by children of different kinds of statement. Some words declare positively (ex., I go). This form of verb is called the *Indicative Mood.* (Show meaning by giving Lat. root, *indico*, I point out.)

Another use of words is to *give commands.* This form is called the *Imperative Mood.* (Lat., *impero*, I command.) (Exs., Go; Come here.) The *Conditional* or *Subjunctive Mood* denotes uncertainty, doubt, or supposition. (Lat., *subjungo*, I subjoin.) (Ex., If I go.) Another form of the verb expresses ability, power, or permission to do a thing. This is sometimes called the *Potential Mood.* (Ex., I may go.) The form of the verb in which no limitation of the idea of doing is stated is called the *Infinitive Mood.* (*Infinitus*, unbounded.) (Ex., To go.)

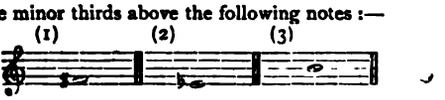
[NOTE.—The above contains matter for a long lesson on Mood, a great number of examples being needed to impress the points thoroughly upon the minds of the children.]

Music.

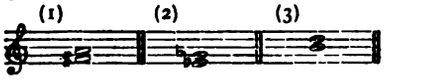
A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both.* The questions in the Tonic Sol-fa Notation will be found at the end.)

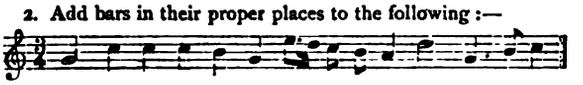
1. Write minor thirds above the following notes :—



1. (1) (2) (3)



2. Add bars in their proper places to the following :—



2.

3. State (briefly) the meanings of the following :—(1) M. 90; (2) *Staccato*; (3) 𝄐.

3. (1) The Metronome is to be set so as to beat 90 per minute; (2) a term used when notes are to be sung short; (3) the Hold—notes over which it is placed are to be held longer than usual.

TONIC SOL-FA NOTATION.

1. Write minor thirds above the following notes :—(1) *soh*; (2) *doh*; (3) te_1.

1. (1) *Soh, ta*; (2) *doh, ma*; (3) te_1, *ray.*

2. Re-write the following in two-pulse measure, halving the value of each note :—

	|	m	:—	|	s	.l	:f	|	r	:d	.t_1	|	f	:m	‖
2.	|	m		:s	,l	.f	|	r	.d	,t_1	:f	.m	‖			

3. State (briefly) the meanings of the following :—(1) M. 90; (2) *Staccato*; (3) 𝄐.

3. (1) That the Metronome is to be set so as to make 90 beats per minute; (2) that the notes over which the sign for which the word stands is placed, are to be sung short; (3) the Hold—it shows that the note above which it is placed must be held longer than usual.

FOURTH YEAR.

Pupil Teachers at end of Fourth Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including No. 1, if you can.

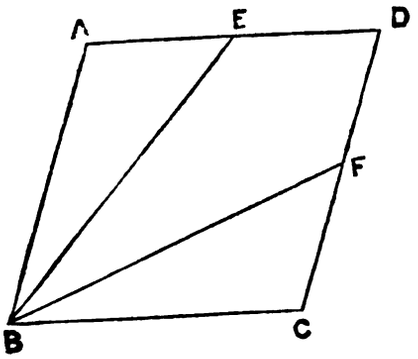
1. A point is taken in each of two adjacent sides of a parallelogram at the same distance from the angle in which they intersect; show that if these points be equally distant from the opposite angle, the parallelogram is a rhombus.

Let ABCD be a parallelogram, and let DE=DF, and EB=FB; then ABCD is a rhombus. Join BD.

Because BE, ED=BF, FD each to each, and base BD is common, ∴ ∠BED=∠BFD (I. 8).

And ∠'s DEB, BEA = ∠'s BFD, BFC (I. 13).

∴ ∠ BEA = ∠ BFC. And opposite ∠'s BAE, BCF are equal (Def.).



∴ ∠'s BEA, BAE = ∠'s BFC, BCF; and side BE = side BF,
∴ (I. 26) BA = BC.
But BA = DC, and BC = AD (Def.)
∴ All sides are equal, and ABCD is a rhombus. Q. E. D.

2. If there be two straight lines, one of which is divided into any number of parts; the rectangle contained by the two straight lines, is equal to the rectangles contained by the undivided line, and the several parts of the divided line.

Give the corresponding formula in Algebra.

Prop. 1, Bk. II.

Let A and BC be the two lines, and BD, DE, and EC the parts of BC.
Let $A = a$, and $BC = b$, and BD, DE, $EC = x, y, z$.
Then $ab = ax + ay + az$.

3. To divide a given straight line into two parts, so that the rectangle contained by the whole and one of the parts may be equal to the square on the other part.

Prop. 11, Bk. II.

Algebra.

Answer two Questions.

1. What fraction is equivalent to the mixed expression :—

$$x^2 + xy + y^2 + \frac{x^2y + y^3}{x - y}$$

Find its value when $x = -\frac{2}{3}$, $y = 1\frac{1}{2}$.

(a)
$$x^2 + xy + y^2 + \frac{x^2y + y^3}{x - y}$$
$$= \frac{(x - y)(x^2 + xy + y^2) + x^2y + y^3}{x - y}$$
$$= \frac{x^3 + x^2y}{x - y}$$
$$= \frac{x^2(x + y)}{x - y} \text{ Ans.}$$

(b)
$$x = -\frac{2}{3},\ y = 1\frac{1}{2}$$
$$\therefore \frac{x^2(x + y)}{x - y}$$
$$= \frac{\frac{4}{9}(1\frac{1}{2} - \frac{2}{3})}{-\frac{2}{3} - 1\frac{1}{2}}$$
$$= \frac{\frac{4}{9} \times \frac{7}{6}}{-1\frac{7}{6}}$$
$$= \frac{\frac{14}{27}}{-1\frac{7}{6}}$$
$$= -\frac{4}{9}. \text{ Ans.}$$

2. Solve the equations :—

$$\left.\begin{array}{l} (1)\ 91x - 68y = 4{\cdot}7 \\ 84x - 51y = 11{\cdot}4 \end{array}\right\}$$
$$(2)\ {\cdot}07x^2 - {\cdot}625x + 1{\cdot}245 = 0$$

and form the equation whose roots are -7, $\frac{3}{5}$.

(1) $91x - 68y = 4{\cdot}7$ (1)
$84x - 51y = 11{\cdot}4$ (2)
Mult. (2) by 4 $336x - 204y = 45\ 6$
(1) by 3 $273x - 204y = 14{\cdot}1$
Subtracting $63x = 31{\cdot}5$
and $x = {\cdot}5$. Ans.

Substituting value of x in (1)
$45{\cdot}5 - 68y = 4{\cdot}7$
$-68y = -40{\cdot}8$
and $y = {\cdot}6$. Ans.

(2) ${\cdot}07x^2 - {\cdot}625x + 1{\cdot}245 = 0$
∴ $70x^2 - 625x = -1245$
and $x^2 - \frac{625x}{70}x = 1\frac{245}{70}$

Completing the square—
$$x^2 - \tfrac{125}{70}x + (\tfrac{125}{140})^2 = -1\tfrac{245}{70} + (\tfrac{125}{140})^2$$
$$\therefore\ x - \tfrac{125}{140} = \pm\tfrac{325}{140}$$
and $x = \frac{125}{140} \pm \frac{325}{140}$
$= 5\frac{13}{14}$ or 3. Ans.

$(x + 7)(x - \frac{3}{5}) = 0$
$= x^2 - \frac{3x}{5} + 7x - 4\frac{1}{5} = 0$
$= 5x^2 + 32x = 21$. Ans.

3. A coach leaves a town travelling $6\frac{1}{2}$ miles per hour; 12 hours afterwards a courier who travels $8\frac{3}{4}$ miles an hour is sent after it. In what time will he overtake the coach?

Let x = time required in hours.
$8\frac{3}{4}x = 6\frac{1}{2}(x + 12)$
$52x = 39x + 468$
∴ $13x = 468$
and $x = 36$ hours. Ans.

Mensuration.

An equilateral triangle and a circle have the same perimeters; compare their areas.

Suppose one side of triangle = 2 ∴ Perimeter = 6
∴ area of triangle = $\sqrt{3(1 \times 1 \times 1)} = \sqrt{3} = 1{\cdot}732$
Perimeter of circle = 6 ∴ Radius = $\frac{1}{2}(6 \div 3\frac{1}{7})$
$= \frac{21}{22}$
Area of circle = $3\frac{1}{7}$ Radius^2
$= \frac{22}{7}(\frac{21}{22})^2$
$= \frac{63}{44}$
Area of triangle : Area of circle :: $1{\cdot}732 : \frac{63}{44}$
$= 38{\cdot}104 : 63$. Ans.

Arithmetic.

FEMALES.

1. I placed £325 in the bank on 10th of January, 1883, and withdrew principal and interest on 5th June. What amount did I withdraw, supposing that the bank paid $3\frac{1}{2}$ per cent.?

From 10th January, 1883, to 5th June = 146 days;
Int. on £325 for 146 days at $3\frac{1}{2}$ per cent.
$$= \frac{325 \times 3\frac{1}{2} \times 146}{100 \times 365} = £4\ 11\text{s.}$$
Amount withdrawn = £325 + £4 11s. = £329 11s. Ans.

2. Divide £224 12s. into parts in the ratio of $\frac{1}{2}$, $1\frac{1}{2}$, and 2.

No. of parts = $\frac{1}{2}$, $1\frac{1}{2}$, 2; or 1, 3, 4 = 8
Divisions = $\frac{1}{8}$ of £224 12s. = £28 1s. 6d. Ans.
$\frac{3}{8}$,, = £84 4s. 6d. Ans.
$\frac{4}{8}$,, = £112 6s. 0d. Ans.

3. How much less shall I receive annually by investing £5,795 in 3 per cents at 95, than if I had placed the same amount in 5 per cents. at 105?

Income from 1st investment = $\frac{5795 \times 3}{95}$ = £183.
Income from 2nd investment = $\frac{5795 \times 5}{105}$ = £275$\frac{11}{21}$.
Less amount received = £275$\frac{11}{21}$ − £183 = £92$\frac{11}{21}$. Ans.

4. A pays £9 3s. 4d. more rates than B, their incomes being equal. Residing in different towns, they are rated at 2s. and 1s. 4d. in the £ respectively. Find the income of each.

Difference of rating per £ = 2s. − 1s. 4d. = 8d.
For every 8d. contained in £9 3s. 4d. they receive £1 income.
∴ Amount of income = 2200 ÷ 8 = £275. Ans.

Grammar.

MALES AND FEMALES.

1. Learning hath *his* infancy, when *it* is *but* beginning and almost childish: then his *youth*, when it is luxuriant and juvenile: *then* his strength of years, when it is solid and *reduced*: and, lastly, his old age, when it *waxeth* dry and *exhaust*. *But* it is not good to look too long upon these *turning* wheels of vicissitude, *lest* we *become* giddy.—BACON.

Analyse this passage down to the word 'exhaust,' and parse the words in italics.

2. Comment on the use of the pronoun 'his' in it, and mention any similar use of it in another passage.

3. Point out any words in the above which have a Latin root.

(1) ANALYSIS.

Sentence.	Kind.	Connective.	Subject.	Predicate.	Object.	Extension.
(*a*) Learning hath his infancy	Princ. Sent.		Learning	hath	his infancy	
(*b*) when it is but beginning	Adj. to *a*	when	it	is but beginning		
(*c*) and almost childish	Adj. to *a*	and	[it]	[is] almost childish		
(*d*) then his youth	P. S. coord. to *a*		[it]	[hath]	his youth	then
(*e*) when it is luxuriant and juvenile	Adj. to *d*	when	it	is luxuriant and juvenile		
(*f*) then his strength of years	P. S. coord. to *a*, *d*		[it]	[hath]	his strength of years	then
(*g*) when it is solid and reduced	Adj. to *f*	when	it	is solid and reduced		
(*h*) and, lastly, his old age	P. S. coord. to *a*, *d*, *f*	and	[it]	[hath]	his old age	lastly
(*i*) when it waxeth dry and exhaust	Adj. to *h*	when	it	waxeth dry and exhaust		

PARSING.

His—pers. pro., neut. (masc. form) sing., 3rd., poss., gov. by 'infancy.'
it—per. pro., neut., sing., 3rd., nom. to 'is beginning.'
but—adv. of deg., mod. 'is beginning.'
youth—abs. noun, neut., sing., 3rd., obj., gov. by 'hath,' und.
then—adv. of time, mod. 'hath.'
reduced—adj. of quality, qual. 'learning.'
waxeth—verb, reg. int., act., ind., pres., sing, 3rd, agreeing with 'it.'
exhaust—adj. of quality, qual. 'learning.'
but—conj., disj., introducing the sentence 'it is not good,' and used correlatively with 'lest.'
turning—pres. participle, used as adj., qual. 'wheels.'
lest—conj., disj., joining the sentences 'it is not good' and 'we become giddy.'
become—irr. intrans. verb, act., ind., pres., sing., agreeing with 'we.'

(2) In Old English the word *his*, a true possessive from *he*, was used indiscriminately for both masculine and neuter genders. It is so used in the passage above. Other examples:—

The tree yielding seed after *his* kind.
If the salt have lost *his* savour.

(3) Infancy, luxuriant, juvenile, solid, reduced, exhaust, vicissitude.

4. Mention any great writers in the eighteenth century and their works.

Alexander Pope (Rape of the Lock, Iliad, Odyssey, Essay on Man), James Thomson (Seasons, Castle of Indolence), poets; Addison and Steele (Spectator, Tatler, etc.), essayists; Hume and Robertson, historians; Dr. Johnson (Dictionary, Lives of Poets, and Rasselas); Adam Smith (Wealth of Nations), economist; Goldsmith (Vicar of Wakefield, Traveller, Deserted Village), poet and novelist; Burns (Songs); Burke (Essays, History of Revolution), statesman, etc.

Geography.

(*Answer two Questions, including Question* 1.)

1. Give 'Notes of a Lesson' on 'The Arrangement of Land and Water on the face of the Earth.' Illustrate by a map.

Introduction.—Show map of world in hemispheres, eastern and western, also land and water hemispheres if possible, and use globe.

Unequal distribution of land and water.—Most land in northern hemisphere, and in temperate zone least in arctic and torrid zones.

Most water in southern hemisphere, and in torrid zone.

Effects of this distribution.—Land made more serviceable for man. He is fitted for temperate climate, cannot do with excess of heat or cold; this distribution a wise provision.

Most water where evaporation can take place easiest. Earth thus supplied with clouds, moisture, rain, etc. Distribution such as to provide best for movements of water, preventing stagnation and putridity.

Benefits derived from this distribution.—Parts man inhabits more accessible, seas enabling him to reach every part easily; provided with vegetable products better than by any other method.

2. Say what you know about Mexico, Guatemala, Cotopaxi, Quito, Lima, Terra del Fuego, Juan Fernandez. Describe each as fully as you can.

Mexico.—A country of N. America, bounded by the United States on the N., W. by Pacific, S. by Central America, and E. by Gulf of Mexico. 1300 miles long, 140 to 700 miles broad in the N. Area, 742,000 sq. miles. Consists of large plateau or table-land, varying from 6000 to 8000 feet in height. Climate, mild and genial, except on low coasts, where it is hot and unhealthy. Soil, fertile. Wild cattle and cochineal insect found in large numbers. Minerals abundant. Capital, same name; 230,000 inhabitants.

Guatemala.—Largest state in C. America, extending from Yucatan to Pacific, and is bounded by Mexico on W., and by Honduras on E. Surface, mountainous, but soil productive. Cochineal and indigo exported in large quantities. Volcanoes numerous, and earthquakes common. Cap. Guatemala, 45,000.

Cotopaxi.—A volcanic mountain of Ecuador, S. America, 34 miles south of Quito. Its shape is conical, rising 19,500 feet above the level of the sea. It is the highest active volcano in America.

Quito.—Situated in a ravine on the E. of the volcano Pichincha, 9543 feet above the sea. Situation delightful, enjoys a perpetual spring climate, while it has within view many peaks covered with perpetual snow. Earthquakes are common, yet it has a pop. of 76,000, and its trade is large in grain and other agricultural produce.

Lima.—Cap. of Peru, on the Rimac. Finest city in S. America. Houses of one storey, owing to earthquakes. Large trade through Callao, its port; university, the oldest in America.

Terra del Fuego.—A group of islands at the south of S. America, separated from mainland by Straits of Magellan. Consists almost entirely of barren rocks, inhabited only by penguins and sea-fowl.

Juan Fernandez.—An island in the Pacific Ocean, 400 miles W. of Chili. 18 miles long and 6 broad. Named after the Spanish navigator by whom it was discovered in 1567. Alexander Selkirk lived on it four years about 1700. De Foe's *Robinson Crusoe* is founded on this event.

3. What are the causes of the tides? Describe the tide in the Bay of Fundy, and say where, in Great Britain, specially strong tides can be seen.

The tides are the movements of the waters of the earth, caused by the attraction of the sun and moon. In its progress round the world, the moon attracts the waters of the earth, which being

free to move follow the moon in its course. The attraction of the sun is of a similar kind, but of less force because of its distance from the earth.

As the tidal wave crosses the Atlantic, it is impeded in its course by the continent of America. The wave is therefore deflected, and the Bay of Fundy becoming narrower, as it goes further inland the volume of water becomes narrowed, and therefore increased in depth. It rushes up with great force and often reaches a height of from 70 to 100 feet. Its ebb is as rapid as its flow.

The tidal wave passing up the British Channel is narrowed in a similar manner, and the tides in that part of the British Isles are of the same character, but as the volume of the tidal wave is not so great, the tides are not so high. In each of the narrow inlets on the W. coast of Great Britain, a similar appearance is seen, but much less in extent.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination papers.

Arithmetic.

MALES.

1. Define a fraction. Explain what is meant by multiplying $\frac{3}{4}$ by $\frac{8}{7}$, and show why $\frac{3}{5}=\frac{6}{10}$.

A fraction is a part or parts of a unit. It is expressed by two numbers, one above the other with a line between them, the lower number being called the denominator, and showing into how many parts the unit is divided, and the upper number being called the numerator, and showing how many of such parts are taken to form the fraction.

Multiplying $\frac{3}{4}$ by $\frac{8}{7}$ means that the fraction $\frac{3}{4}$ has first to be multiplied by 5, thus becoming $\frac{15}{4}$. This number, however, is 7 times too great, and $\frac{15}{4}$ has therefore to be divided by 7. As 15 cannot be divided by 7 without a remainder, the denominator is multiplied by 7, and each of $\frac{15}{4}$ becomes $\frac{1}{7}$ the part of what it was before, viz., $\frac{1}{28}$, and the result obtained is $\frac{15}{28}$.

A line 15 inches long can be divided into parts of 1 inch each, the inch being $\frac{1}{15}$ of the whole. $\frac{6}{15}$ would be 6 inches. The same line could be divided into 5 parts, each part being 3 inches long. 2 of such parts ($\frac{2}{5}$) would = 6 inches. It is thus seen that $\frac{2}{5}$ of the line $=\frac{6}{15}$ of the same line.

The same reasoning would apply to abstract quantities.

2. Find how many yards of carpet, 27 inches wide, will cover a room 24 feet 6 in. long by 18 feet wide; and its cost at 4s. 6d. a yard.

$$\text{Length of carpet in yards}=\frac{24\frac{1}{2}\times 18}{2\frac{1}{4}\times 3}$$
$$=\frac{49}{2}\times\frac{1}{9}\times\frac{8}{3}\times\frac{1}{3}$$
$$=65\tfrac{1}{3}\text{ yards.}\quad\text{Ans.}$$

$$\text{Cost}=4\tfrac{1}{2}\text{s.}\times 65\tfrac{1}{3}$$
$$=\tfrac{9}{2}\times\tfrac{196}{3}$$
$$=294$$
$$=£14\ 14\text{s.}\quad\text{Ans.}$$

3. What change is made in a man's income by his transferring £11,000 from the 3 per cents. at $101\frac{3}{4}$ into $4\frac{1}{2}$ per cent. debentures at $137\frac{1}{2}$, the usual brokerage being charged on each transaction?

$$\text{First income}=\frac{11000\times 3}{100}=£330$$
$$\text{Proceeds of sale}=\frac{11000\times(101\frac{3}{4}-\frac{1}{2})}{100}$$
$$=£11137\tfrac{1}{2}$$
$$\text{Second income}=\frac{11137\frac{1}{2}\times 4\frac{1}{2}}{137\frac{1}{2}+\frac{1}{2}}$$
$$=£364\ 10\text{s.}$$
$$\text{Change made}=£364\ 10\text{s.}-£330$$
$$=£34\ 10\text{s. gain.}\quad\text{Ans.}$$

4. The sum of £15 10s. is to be divided amongst 3 men, 5 women, and 8 boys, so that for every shilling a man gets a woman gets 8d. and a boy 6d. Find the share of each.

		s.
The men will get	$12\times 3=$	36
while the women	$8\times 5=$	40
and the boys	$6\times 8=$	48
		124

Each man will get $\frac{1}{2}$ of $\frac{36}{124}$ of $310=30\text{s.}$ Ans.
„ woman „ $\frac{1}{2}$ of $\frac{40}{124}$ of $310=20\text{s.}$ Ans.
„ boy „ $\frac{1}{2}$ of $\frac{48}{124}$ of $310=15\text{s.}$ Ans.

History.

MALES AND FEMALES.

1. Give some evidence of the growing power of the House of Commons under James I.

The first Parliament of James I. framed an 'Apology,' showing that they held their privileges 'by right and not by grace.' The second Parliament declined to grant supplies till illegal impositions and other grievances were redressed. They were dismissed because of this, but when the third Parliament was called, the same spirit showed itself. Monopolies were attacked, their authors impeached, and the venality of Lord Bacon punished. One of their number was imprisoned, and a petition was presented to the king. Then came the protestation in which they declared that their privileges were the undoubted birthright of the people of England. This was the real beginning of the contest between king and people for the supreme power in the country. It ended in the dethronement of the Stuarts.

2. What part did England take in the war of the Spanish succession? And why?

England joined the Grand Alliance against France, and the campaigns in which the battles of Blenheim, Ramilies, Almanza, Oudenarde, and Malplaquet, were fought, were joined in by the English, under Marlborough. Gibraltar was also taken by Sir George Rooke, while the Earl of Peterborough was successful in Spain.

Great fears were entertained respecting the growing power of France and her claims to the Spanish throne rendered vacant by the death of Charles in 1700. To prevent the excess of power, the Spanish dominions had been partitioned in treaties among the rival claimants, to which work France had assented, but in despite of this, the French king accepted for his grandson the whole of the Spanish dominions, and also supported the claims of the Pretender to the English throne. William desired to take such steps, and the nation wished it also, as would punish him for his perfidy, cause reparation to be made for the insult to this country, and prevent this access of power. These reasons led to the war of the Spanish succession.

3. 'Of a Spanish invasion,' said Lord Chatham in his last speech, 'of a French invasion, of a Dutch invasion, many noble lords may have read in history; and some lords,' here he looked keenly at Lord Mansfield, 'may perhaps remember a Scotch invasion.' Describe, with dates, the invasions of England alluded to in this extract.

The Spanish invasion was attempted by Philip II. of Spain, in 1588. A great fleet was prepared, and an army ready in the neighbourhood of Dunkirk. The English fleet, however, succeeded in destroying a large proportion of the ships, and no landing was ever effected. A small proportion of the ships reached Spain.

Louis II., the eldest son of the king of France, landed in England in 1216 for the purpose of driving John from the throne. Many of the barons joined him, but grew jealous when they saw him offer lands and castles to his friends. After John's death, two battles were fought, one in Lincoln and the other on the sea, in which Louis was defeated. He then made peace and went home.

In 1666, the Dutch fought against England, and in 1667, a fleet sailed up the Medway, burned the ships at Chatham, and blockaded the river Thames. Evelyn's diary records the pain with which he noted the dishonour thus done to his country, a disgrace never to be wiped off.

The Young Pretender in 1745 tried to regain the throne for the Stuarts. He landed at Inverness, fought the battle of Prestonpans, evaded the Duke of Cumberland, marching southwards as far as Derby, and causing a great panic in the country. Being inadequately supported by the English, he retraced his steps, and was defeated at Culloden.

Teaching.

Write out notes of a lesson on 'Good Manners.'

Introduce the lesson by speaking of the motto on one of the great schools of the country, 'Manners make the man.' Then xplain what is meant and included in the word 'Manners.'

Manners of two kinds.—Good and bad. How boys are distinguished from each other: By their actions, behaviour, mode of speech, their conduct towards all who come near them.

Distinguishing features.—Good: calm, gentle, and respectful in speech. In actions—kind and friendly towards equals; obedient towards superiors; helpful towards all in need. Respect shown to the feelings of others.

Bad: Exactly opposite to above; rough and rude in speech, disrespectful, unkindly, disobedient, harmful, inconsiderate in action.

Effect of different manners.—Producing a pleasant, agreeable feeling and sympathy if good, otherwise if bad. Company sought of those who have good manners. Shunned if bad. Success likely to follow the lad with good manners.

Give examples of different effects produced by different manners, with illustrations from personal experience if possible.

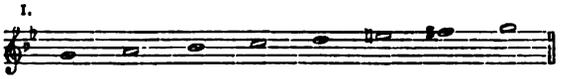
Music.

A quarter of an hour allowed for this paper.

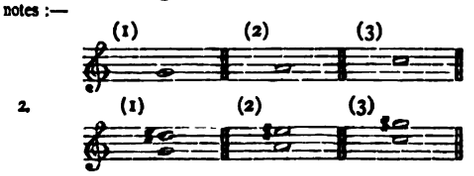
(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write in the Treble clef the signature and the ascending scale of G minor, using the major or sharp sixth, and the sharp seventh.

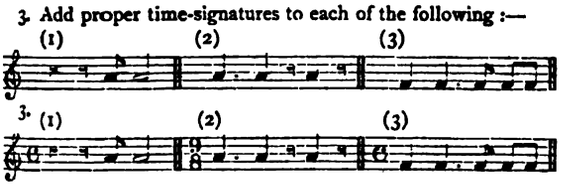
1.



2. Write an augmented fifth above each of the following notes:—



3. Add proper time-signatures to each of the following:—



TONIC SOL-FA NOTATION.

1. Write an augmented fifth above each of the following notes:—(1) *fah*; (2) *doh*; (3) *ray*.

1. (1) *fah, de*^{1}; (2) *doh, se*; (3) *ray, le*.

2. Write the minor scale (*lah* mode), using the minor or flat sixth, and the major or sharp seventh.

2. l, t, d r m f se l

3. Write the following in six-pulse measure by trebling the value of every note:—

|s ,l :s ,f ,r |m :d ||

3. |s :—:l |s :f :r |m :—:—|d :—:—||

Messrs. Griffith and Farran will shortly publish a set of Test Cards in Arithmetic, printed as Duplex Cards, with Mental Arithmetic exercises on one side and Arithmetic for the Standards on the other. They will be strictly based on Schedule I of the Code of Regulations just issued by the Education Department and on the published instructions to Inspectors.

As these Cards will be precisely similar to questions set at the Government Examinations, Teachers using them will have a reliable means of gauging the condition of their schools at any preliminary test examination they may hold.

ANSWERS TO ARITHMETICAL QUESTIONS IN THE 'SCHOLAR' FOR MAY, 1884.

STANDARD III.

(1) 4085.
(2) 14+1694.
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(1) £13776 5s. 4$\frac{1}{2}$d.
(2) £264,645 5s. 10d.
(3) £1256 14s. 11$\frac{1}{2}$d.+70.
(4) £78 14s. 10$\frac{3}{4}$d.
(5) £306 17s. 8$\frac{3}{4}$d.
(6) 76 tons 14 cwt. 2 qrs. 21 lbs. 1 oz.
(7) 1,085,440 drams.
(8) £706 13s. 4d.
(9) 1833 stones 5 lbs. 11 oz.
(10) £40.
(11) £30 7s. 4d.
(12) £13 15s.

STANDARD V.

(1) £606,479 17s. 1d.
(2) 60 yards.
(3) Calico, £1 19s.; cloth, 12s. 3d.; merino, £17 1s. 2$\frac{1}{2}$d.; silk, £86; total, £105 12s. 5$\frac{1}{2}$d.
(4) One-fifth.
(5) £4911 0s. 6d.
(6) £39 8s. 1$\frac{1}{2}$d.
(7) £1125.
(8) £13 16s. 8d.
(9) £128 3s. 5$\frac{3}{4}$d.
(10) £7 17s. 1$\frac{3}{4}$d.
(11) 24 oz.
(12) $\frac{11}{110}$.

STANDARD VI.

(1) £28 7s.
(2) $\frac{804}{3177}$.
(3) £7 8s. 10$\frac{1}{2}$d.
(4) 46·55165.
(5) £33 13s. 3$\frac{3}{4}$d.
(6) £25.
(7) £1 8s. and 14s.
(8) 8·72 persons.
(9) £3 14s. 9·2d.
(10) $\frac{1}{7}$.
(11) 542·1875
(12) 21·428 days.

STANDARD VII.

(1) 104$\frac{81}{10}$.
(2) 1s. 10$\frac{3}{4}$d.
(3) £120 5s. 11$\frac{20}{101}$d.
(4) £31.

ANSWERS TO ARITHMETICAL QUESTIONS IN THE 'LITTLE LEARNER' FOR MAY, 1884.

STANDARD I.

(1) 2446
(2) 641
(3) 95
(4) 2723
(5) 341
(6) 64
(7) 3456
(8) 666
(9) 87
(10) 2369
(11) 3731
(12) 1684
(13) 2357
(14) 189
(15) 2173
(16) 389

STANDARD II.

(1) 40,189
(2) 11,899
(3) 21,175,703
(4) 39,173,730
(5) 7172+5
(6) 3904+3
(7) 4,672,580
(8) 4,923,644
(9) 32,669
(10) 10,676
(11) 1089+6
(12) 63,611
(13) 50,529,339
(14) 9845+4
(15) 52,973
(16) 4922+10
(17) 5,482,070
(18) 4687
(19) 26,602
(20) 2843+2

Owing to pressure on our space, the continuation of Dr. Coupland's 'Discipline of the Mind' is unavoidably held over.

K

Mr. Richard Greenwood,

President of the National Union of Elementary Teachers.

THE conference of the National Union of Elementary Teachers, recently held at Leicester, derived no small part of its success from the able and comprehensive address delivered by the new President, Mr. Richard Greenwood. It is, therefore, not inappropriate to give our readers a sketch of Mr. Greenwood's career.

Mr. Greenwood is a native of Cornwall, and is now forty-six years of age, having been born in Truro in the year 1838. At the age of thirteen, he became a pupil teacher in the Central Schools of his native town. At the close of his apprenticeship, he took a good position on the list of First-class Queen's

Scholars, and entered the Exeter Training College, where he remained for a period of two years and a quarter. During his residence in college, he distinguished himself not only by carrying off many of the college prizes, but also by winning the regard and esteem of his tutors and fellow-students. His geniality of disposition, his devotion to duty, and his almost stern adhesion to whatever he considered a matter of conscience or of principle, gained for him at this stage of his career the respect and confidence of all who came in contact with him. At the close of his college course he was appointed to the Mastership of the National School (mixed) of Kilkhampton, a pleasant but retired village of North Cornwall, where he is remembered with pride and affection by his former pupils. Here Mr. Greenwood laboured for a period of twelve years, and here he must have acquired that knowledge of the special difficulties and circumstances of country schools, which is evidenced in his presidential address. Earnest, practical, and high-principled, he exercised a wholesome and manly influence over the young people of Kilkhampton, and was regarded by the Rev. Canon Thynne, the Rector, as a personal friend and fellow-worker. In 1867 Mr. Greenwood's certificate was raised to the 'First-class,' and in the report of the Education Department for 1869-70, his school is mentioned as 'one of the best in the county.' From Kilkhampton, Mr. Greenwood removed in 1871 to the Parochial (Endowed) School of St. Saviour, Southwark, a change of the most complete character. Here, too, success attended his indefatigable efforts. The school became one of the most popular and successful in South London, and during the three years of Mr. Greenwood's mastership, largely increased both in numbers and efficiency. In 1874 the Inspector for the district strongly recommended Mr. Greenwood to the London School Board, and in July of that year, he was appointed Head-master of the Board School, Jamaica Level, Bermondsey (now known as the Southwark Park Board School), a post he still occupies. The successive reports of the Inspectors show that the work done in this school is of a thorough and sterling kind. One of the early reports states, that 'This school is becoming one of the very best under my inspection. In each department the classes are well arranged, the teaching power judiciously distributed, and sound methods of instruction employed. The children work with neatness, accuracy, and despatch. Order and discipline are good, and a nice tone pervades every part of the school.' Mr. Greenwood has not confined his teaching to the 'bare bones of the rudiments.' In 1877, one of his scholars carried off the Mortimer Memorial Scholarship, and in 1878,

another headed the list, taking a Clothworkers' Scholarship. In 1879, his pupils gained three of the five open scholarships at St. Olave's Grammar School, Southwark, and in 1880, two others were equally successful. The total value of the scholarships gained by scholars from the Southwark Park Board School now amounts to more than £1,000. Such a record of professional success is worthy of the President of the National Union. Mr. Greenwood is a strong advocate of Physical Education, and, as an enthusiastic cricketer, has himself done something by his example for its extension. Amidst the pressure of his scholastic duties, Mr. Greenwood has found time to take part in many educational and professional movements. For many years he has been an active member of the Committee of Church Teachers' Benevolent Institution, of which he was one of the founders. Shortly after removing to London he became the first Secretary of the Southwark Teachers' Association, a post he held for six years, and in 1874 he was elected a member of the Executive of the National Union. In 1875 and 1876 he devoted much attention to the establishment of the Teachers' Provident Society, and became the first Chairman of its General Board of Management. He was also Chairman of the Committee which drew up the Schemes for the Teachers' Benevolent and Orphanage Funds. In 1878 he was elected General Treasurer of the Union, a post he held for five years, until in 1883 he was elected Vice-President. At the Conference just held he was inducted into the presidential chair by his predecessor, Mr. Dawson, B.A., who in introducing him said, 'From the time and attention, the trouble and zeal that he has devoted in the past to the work of the Union, in ascertaining the needs of teachers, and in trying to get them satisfied, and from the great ability that he can bring to bear upon different subjects, I am quite sure he will fully maintain the honour of the Union and justify your choice in electing him as your President.' The experience of the Leicester Conference shows that the confidence of the Union was not misplaced. Mr. Greenwood presided over the meetings with tact, urbanity, and dignity, and, on occasion, showed himself equal to any emergency. We trust that under his chairmanship the Executive will accomplish much useful work, and show that the National Union of Elementary Teachers is labouring as earnestly for the good of education as for the welfare and position of teachers.

Matriculation Hints.

By Henry A. Reatchlous, M.A. (Lond.), B.Sc.,
Westminster Training College.

Latin.—We give a translation of the passages set for practice last month. The student should compare his own version with the one below. Let him try to avoid being too literal. The examiners know quite well the exact force of the expressions used by the author, and in offering for the meaning of a phrase the meanings of the separate words, the candidate does not show his knowledge, but the want of it.

(1) He is a man of distinguished courage, but I am sorry you have made him general, for his prudence is not equal to his valour, nor his wisdom to his prudence.

(2) After the storming of Carthage, Scipio circulated despatches through all the cities of Sicily, bidding them to send envoys to reclaim the ornaments of their temples which had been plundered by the Carthagenians, and have them replaced in their original positions.

The following two pieces were set in June, 1881:—

(1) Legiones duas Romanas habebat Postumius, sociorumque ab supero mari tantum conscripserat ut viginti quinque milia armatorum in agros hostium induxerit. Galli oram extremæ silvæ eum circumsedissent ubi intravit agmen saltum, tum extremas arborum succisarum impellunt. Quæ alia in aliam incidentes ancipiti strage arma viros equos obruerunt ut vix decem homines effugerent.

(2) Nostra victoria est, si quia Di vatesve eorum in futurum vident. Itaque ut decet certæ spei plenos et cum imparibus manus conserturos pilis ante pedes positis gladiis tantum dextras armemus. Ubi illi vana injicerint missilia tum micent gladii et veniat in mentem unicuique deos esse qui Romanorum adjuvent.

Those who intend matriculating very soon, will no doubt be glad to see the Greek passages set at the same examination. Translations will appear in the Practical Teacher for June.

(*a*) σίγησον, ὦ τάλαινα, μὴ φίλους φόβει.

(*b*) πῦρ καὶ ὕδωρ καὶ γῆν καὶ ἀέρα φύσει πάντα εἶναι καὶ τύχῃ φασί, τεχνῃ δὲ οὐδὲν τούτων.

(*c*) ὡς τοίνυν ἐστιν ἀληθῆ τὰ μεμαρτυρημένα, οὔτ' αὐτὸν τοῦτον οὔτ' ἄλλον ὑπὲρ τούτου δεῖξαι δυνήσεσθαι νομίζω.

(*d*) δοκοῦσί μοι πάντες οἱ πρόσθεν εἰρηκότες τοὺς ἀνθρώπους εὐδαιμονίζειν τῶν ἀγαθῶν ὧν ὁ θεὸς αὐτοῖς αἴτιος.

Natural Philosophy.—The student is advised to begin his study of Mechanics with the Laws of motion. It is above all things necessary that his notions of such terms as velocity, acceleration, force, energy, mass, should be clear and accurate. And a want of uniformity in exposition, and an attempt at over-simplification have done a good deal to confuse a beginner. **Velocity** is the rate of motion of a body, and when uniform, is measured by the space passed over in a unit of time; if variable, it is measured at any instant by the space that would be passed over in a unit of time if the velocity remained constant during the unit and of the same value as at the instant under consideration. The velocity will be greater as the space passed over is greater, and as the time occupied is less; hence the unit of length is involved directly, and that of time inversely; $V = \frac{\text{space}}{\text{time}} = \frac{L}{T}$. We may select as our fundamental units (since all other units are derived from them), the foot, pound, and second, or the centimetre, gramme, and second. In either case it is easy to see what change in the number expressing the velocity is involved in a change of the fundamental units. Suppose the velocity is 88 feet per second; this would plainly be $88 \times \frac{3600}{1760 \times 3} = 60$ miles per hour. **Acceleration** is rate of change of velocity. It varies, therefore, directly as the velocity acquired, and inversely as the time in acquiring it; $A = \frac{\text{velocity}}{\text{time}} = \frac{L}{T} \times \frac{1}{T} = \frac{L}{T^2}$. There is a double reference to the unit of time. Hence if an acceleration be expressed by 32 when the units are a foot and a second, it would be expressed by $32 \times \frac{60 \times 60}{3} = 38{,}400$ when the units are a yard and a minute. Acceleration must never be expressed as merely so many feet per second; that would be a velocity. There must always be a second reference to time; for it makes all the difference in the world whether one foot per second is added to the velocity of a body, per second, per minute, or per hour. Acceleration, therefore, must be expressed as so many feet per second per second, or so many feet per second in a second.

It is not necessary to complete the study of the subjects dealt with in Section A before proceeding to those comprised in Section B. It will be a relief to take them together. There used to be a very general impression that the subjects treated of in the second section could be got up from books, and many persons seem to think so still. But the opinion is gaining ground that this method of learning physics is out of date; the sooner it is entirely abandoned the better. Let the student repeat the experiments for himself wherever it is possible for him to do so, and, in some instances, make as exact measurements as he can of the quantities involved. Such work has a wonderful charm and suggestiveness; it makes study more attractive as well as more real. To illustrate what we mean we will take the subject of Optics, in which the candidate has to study the laws of reflection and refraction, and the formation of images by mirrors and simple lenses. Place a candle in front of a looking-glass; notice the virtual image, erect, of the same size, and as far behind the mirror as the object is in front. Now rotate the mirror; the image will move through 90 degrees while the mirror moves through 45, *i.e.*, the image travels with twice the angular velocity of the mirror. Make diagrams on paper to represent this. Observe that the laws of reflection account for it. Move the mirror toward or away from the candle, the image will move through twice the distance. Draw a diagram for this also. Hold a glowing match before a mirror; notice the two images, the first faint, the second brighter. Prove by a diagram that the distance between the two images is twice the thickness of the glass plate. Now take two mirrors and hold them at angles of 90°, 60°, 30°; observe how the number of images increases. Then put a bright object between them and hold them parallel to each other; the number of images (theoretically infinite) will be considerable.

With curved surfaces the necessity for verification is still greater. Get a concave spherical reflector and a polished ball. The images formed by the latter are always erect, diminished, and virtual.

Now take the concave mirror: fix it on a table and place a candle between it and the wall. With a little patience it will be easy, especially if there is no light in the room except from the candle, to throw a clear image on the wall. Now measure the distance of the candle and the image from the mirror, and call the distances u and v respectively, then the radius of curvature of the mirror is $\frac{u\,v}{u+v}$. Make three such measurements with different values for u and v: the average of the three will be a near approximation to the truth. The measurements can be made with a common ruler or with one marked in centimetres, or the results can be converted by remembering that there are 25·4 m.m in an inch. Verify the facts that with a concave mirror the image may be (1) real, inverted, and magnified; (2) real, inverted, and diminished; (3) virtual, erect, and magnified. Observe, also, that in (1) and (2) object and image may change places. We learn from the formula $\frac{1}{v}+\frac{1}{u}=\frac{2}{r}$, that if the object be at the centre of curvature the image will be there also. Verify this. By carefully tilting the mirror an image of the candle can be thrown upon the candle itself; the image is of the same size as the object but inverted. Hence this is a second method of obtaining the radius of curvature (or the focal length, which is the half of it), and it only involves one measurement.

We now need a convex lens or two and a concave one. First take a convex lens and arrange it on the table, and focus an image of the candle on the wall. If we move the lens a little too much one way the image will have a bluish edge, and a reddish one if we move it too much the other. The right position lies between the two. Now measure the distance of the object and the image from the lens, and denoting them by u and v respectively, the focal length is $\frac{u\,v}{u+v}$; take these measurements in different positions, and the average will usually be very near the truth.

To find the focal length of a concave lens, place it beside a convex lens of shorter focal length, and as the combination will then act as a convex lens, the focal length of the combination can be found as before: call that F; then find the focal length of the single convex lens, call it f, then the focal length, f_1 of the concave lens can be calculated from the formula $\frac{1}{F}=\frac{1}{f}-\frac{1}{f_1}$. Diagrams illustrating what has taken place should be drawn. Of course the focal length of a concave mirror or convex lens can be got from a parallel beam of light, as from the sun; but it is useful and necessary to understand other methods as well. The convex lens can be used as a magnifier; its function being to permit us viewing an object nearer than we could do without it. If we could see an object distinctly without it at a distance of five inches, and with it at a distance of half-an-inch, it would magnify ten times; and if d be distance of distinct vision, and x the focal length of a convex lens, its magnifying power is $1+\frac{d}{x}$. There is only one formula needed for mirrors and one for lenses, if due regard is paid to the convention about signs. If an object is placed before a concave lens or before a convex lens (at a distance less than its focal length), the rays, after passing through the lens, appear to have diverged from a point near or farther from the lens than the object itself. This distance can be found from the formula $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$, when we know the focal length of the lens and the distance of the object. And, further, if we know the distance we wish to place an object from the eye, and the distance we wish it to appear to be, we can find the focal length of the spectacles we must employ.

ST. ANDREWS UNIVERSITY L.L.A. EXAMINATIONS.—These examinations were held on the 14th, 15th, 16th, and 17th April, at nine different centres in Scotland, England, and Ireland. Two new centres—Birmingham and Leicester—have been added this year, and a special examination has been held at Oporto, and also in Shetland. The present centres are St. Andrews, Edinburgh, Aberdeen, London, Bristol, Halifax, Birmingham, Leicester, and Belfast. Three hundred and sixty candidates were entered for the above centres, and the subjects of examination have been Latin, Mathematics, Logic, Moral Philosophy, Natural Philosophy, English Literature, Education, Comparative Philology, History, Political Economy, French, German, Italian, Hebrew, Botany, Physiology, Zoology, Geology, and Church History. The prospectus for 1885 has just been issued, and all intending candidates who wish to obtain information with respect to subjects and regulations, may obtain copies on application to the Secretary, at the University Library, St. Andrews.

Query Column.

RULES.

1. Each correspondent is restricted to *one question*. We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.

2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.

3. ☞ **When a pseudonym is adopted it should be written at the end of the query, and the real name and address on a separate piece of paper.**

4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.

5. Replies will not be sent through the post.

6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—'*The Query Editor*,' *The Practical Teacher*, *Pilgrim Street, Ludgate Hill, London, E.C.*

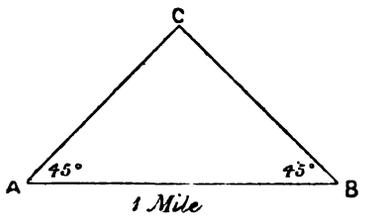
General.

1. LIA FAIL.—

SENTENCE.	KIND OF SENT.	CONNECTIVE.	SUBJECT.	PREDICATE.	OBJECT.	EXTENSION OF PRED.
(*a*) The harp now hangs as mute on Tara's walls	Princ. Sent.		The harp as mute	hangs		now (time) on Tara's walls (place)
(*b*) that once through Tara's halls the soul of music shed	Adj. Sent. to *harp* in (*a*)		that	shed	the soul of music	through Tara's halls (place) once (time)
(*c*) as [it would hang]	Adv. Sent. (manner) to (*a*) contracted	as	[it]	[would hang]		
(*d*) if that soul were fled	Adv. Sent. of condition to (*c*)	if	that soul	were fled		

Harp—com. noun, neut., sing., 3rd, nom, to 'hangs.'
that—rel. pro., neut., sing., 3rd, nom. to 'shed.'
once—adv. of time, mod. 'shed.'
through—prep., showing relation between 'halls' and 'shed.'
Tara's—prop. noun, neut., sing., poss., gov. by 'halls.'
halls—com. noun, plur., neut., obj., gov. by 'through.'
soul—com. noun, neut., sing., obj., gov. by 'shed.'
of—prep., showing rel. between 'music' and 'soul.'
music—com. noun, neut., sing., obj., gov. by 'of.'
shed—irr. trans. verb, act., ind., past, 3rd, sing., agreeing with its nom. 'that.'
now—adv. of time, modg. 'hangs.'
hangs—irreg. intrans. verb, act., ind. pres., 3rd, sing., agreeing with its nom. 'harp.'
as—adv. of deg., modg. 'mute.'
mute—adj. of qual., qual. 'harp.'
as—conj., cop., joining 'harp now hangs' and 'it would hang.'
if—conj., cop., joining 'it would hang' understood and 'that soul were fled.'
that—distg. adj., qual. 'soul.'
soul—com. noun, neut. sing., 3rd, nom. to 'were fled.'
were—irr. intrans. verb, aux. to 'fled,' indicating pass. voice.
fled—past part. of 'to flee,' referring to 'soul.'
were fled—irr. trans., pass., cond., past, 3rd, sing., agreeing with 'soul.'

2. REX.—From each of two stations, east and west of each other, the altitude of a balloon is observed to be 45°, and its bearings to be respectively N.W. and N.E.: if the stations be 1 mile apart, determine the height of the balloon. (*Lock's Elementary Trigonometry.*)



In the triangle ABC, the angles CAB, CBA are equal, therefore AC=BC (I. 6.), and angle ACB is a right angle. (I. 32.)

$\therefore AC^2+BC^2=AB^2$

$2AC^2=(1\text{ mile})^2=(5280\text{ ft.})^2=27,878,400\text{ sq. ft.}$

$AC^2=13,939,200\text{ sq. ft.}$

$\therefore AC=\sqrt{13,939,200\text{ sq. ft.}}=3733{\cdot}5\ldots\text{ft.}$

∴ Distance of balloon from observers $=3733{\cdot}5\ldots\text{ft.}$

3. NIL DESPERANDUM.—See answers to others. *Egan's* 'Exercises on Euclid' may be included.

4. PRECEPTOR.—The Students' (Hallam) Constitutional History of England.

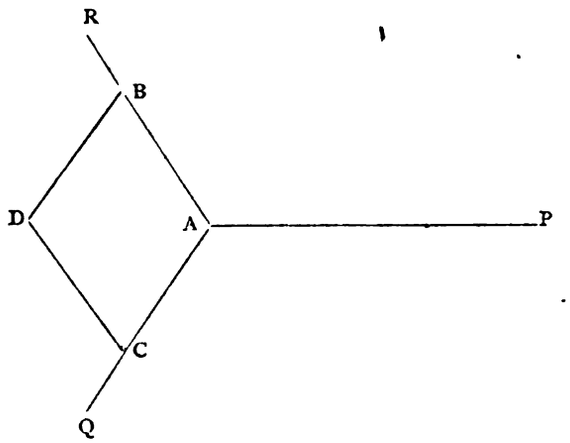
5. DUBITO.—The fact that you are 'not a P.-T.' will be of no advantage.

6. A. J. WOOD might find the Civil Service Year-Book useful.

7. CZECH.—The 'marks' assigned are not known. Your writing is too uncertain to gain more than sixty per cent.

8. Mark off along AR a part AB representing the force exerted by the man at R, and along AQ a part AC representing the force exerted by the man at Q. Through B draw a line parallel to AQ; through C draw a line parallel to AR; let D be the point of meeting of these two lines. Join AD. AD represents the resultant of the two tensions due to the men. It there-

fore represents the pressure on the tree. This pressure is transmitted along AP.



9. DOUBTFUL.—

Sentence.	Kind of Sentence.	Conn.	Subject.	Predicate.	Object.	Ext. of Pred.
(*a*) He is listened to] more	Principal Sentence.		He	is listened [to]		more
(*b*) that no more [words] must say	Adj. to 'he' in *a*	*In rel.*	that	must say	no more [words]	
(*c*) than they [are listened to much]	Adv. sent. (manner) to *a*	than	they	[are listened to]		[much]
(*d*) whom youth and ease have taught to glose.	Adj. to 'they' in *c*.	In rel.	youth and ease	have taught	whom to glose	

He—Pers. pro., masc., sing., 3rd, nom. to 'is listened to.'
that—Rel. pron., agreeing with its ant. 'he,' masc., sing., 3rd, nom. to 'must say.'
no—Adv. of deg., mod. 'more.'
more—Adj. of number, qual. 'words' und.
must—Aux. verb to 'say,' indicating pot. mood.
say—Irr. trans. verb, act., inf., pres., gov. by 'must.'
must say—Irr. trans. verb, act., pot., pres., 3rd, sing., agreeing with its nom. 'that.'
is—Aux. verb to 'listened,' indicating passive voice.
listened—Past part. of the verb 'to listen,' refg. to 'he.'
is listened [to]—Prep.-verb, reg. trans., pass., ind., pres., 3rd, sing., agr. with its nom. 'he.' (See *note.*)
more—Adv. of quantity, mod. 'is listened to.'
than—Cop. conj., correlative to 'more,' joining the sents. 'he is listened [to]' and 'they are listened [to].'
they—Pers. pron., com., plu., 3rd, nom. to 'are listened to' und.
whom—Rel. pron., com,, plu., 3rd, obj., governed by 'have taught.'
youth—Abs. noun, neut., sing., 3rd, nom. to 'has taught,' included in 'have taught.'
and—Cop. conj., joining the sents. 'youth has taught' and 'pleasure has taught.'
pleasure—Abs. noun, neut., sing., 3rd, nom. to 'has taught,' included in 'have taught.'
have—Aux. verb to 'taught,' indicating perfect tense.
taught—Past part. of 'to teach,' refg. to 'whom.'
to—Particle, indicating inf. mood.
to glose—Reg. int. verb, act., inf., pres., used as abs. noun, neut., sing., 3rd, gov. by 'have taught.'

Note.—The word *to* is understood after *is listened*, and '*to*' may be parsed either as an adverb, or, as in the text, making with *is listened* a prep.-verb.

10. BON SOIR.—(1) The solution of your query appeared in our issue for March, 1883. (2) Your writing is *pretty good*, but it is rather *too small*.

11. ANXIOUS.—Your query was solved in our issue for May, 1882.

12. QUESITA.—You will find the solution of your query in our issue for May, 1882.

13. LAKE GENEVA.—Full marks. A round hand is the best.

14. RESOLUTE HELMET.—Our space is too limited to accede to your request, but any particular question will gladly be dealt with.

15. A SUBSCRIBER can obtain the Civil Service Arithmetic, published by Crosby and Lockwood. *Mansford's* or *Fitch's* will explain the principles.

16. SUBSCRIBER should write to Dr. J. C. Meredith, Sec., Royal University of Ireland, Earlsford Terrace, Dublin.

17. W. TEMPEST.—Your P. T. must fulfil his engagement according to the agreement (Schedule IV). See if he was apprenticed for the full four years.

18. FIDUS ACHATES will find his query answered in our replies 'Emperor' and 'Cicero,' page 90, last month. Both English subjects should be prepared.

19. NELLIE.—Almost any text-book; but learn the *Map* of the British Isles. Study also the National Society's Manual, 'The Science and Art of Teaching.'

20. GEOGRAPHY.—The parallels are usually arcs of concentric circles, whose common centre is outside the Map, N. or S. The meridians are equidistant on the same parallels. Get A. Gardner's 'How to draw a Map' (Hughes). Your writing is good in promise.

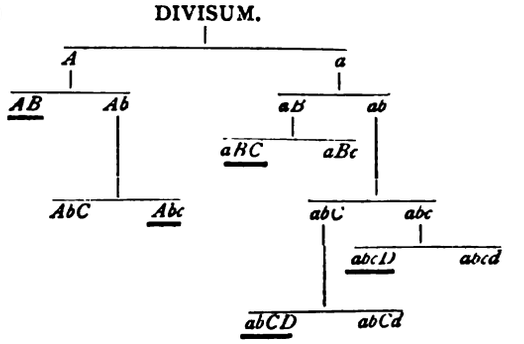
21. B.A.—What is meant by saying 'Divisio non faciat saltum'? How do you know that a 'saltus' has not been made?

Draw up a logical scheme of divisions so as to indicate the places of the following: AB, Abc, abCD, aBC, abcD; a, b, c, d, representing privative terms.

(*a*) In descending from a high genus to a species, we must avoid a sudden leap over any of the subaltern genera in the series. Each of the dividing members must come directly from the division of its own proximate genus. This is expressed by saying, Divisio ne fiat per saltum vel hiatum, or, Divisio non faciat saltum. The ordinary division of natural objects into animals, vegetables, and minerals is faulty; these are not co-ordinate: one step has been omitted. The division should be into organic and inorganic, and then the latter into vegetable and animal.

(*b*) We should know there had not been a saltus if, on making a table, such as the following, each term appeared in its proper place, none being left out.

(*c*)



Arithmetic.

1. J. ALLESTON.—Two dozen of port and 16 bottles of sherry were bought for two equal sums of money. If the quantities of the wines had been reversed, the sherry would have cost £3 more than the port. What was the price of each wine per bottle? (*Pupil Teachers' Examination.*)

16 bottles of sherry cost as much as 24 bottles of port,
∴ 1 bottle ,, ,, $\frac{24}{16}=\frac{3}{2}$,,
24 bottles ,, ,, $\frac{3}{2}\times 24=36$,,
∴ (36 – 16) bottles of port cost £3,
20 ,, ,,
∴ Price of a bottle of port $=£3\div 20=3s.$;
,, ,, sherry $=3s.\times\frac{5}{3}=4s.\ 6d.$

Note.—Perhaps 90 per cent.

2. PW.—A, B, and C are partners; A receives $\frac{1}{3}$ profits; and B twice as much as C; find the capital of C, A's income being diminished £40 by a fall of $\frac{1}{4}$ per cent. in the rate of profit. (*Barnard Smith.*)

A's capital = $\frac{1}{2}$ of total capital,
C's ,, = $\frac{1}{2}$ of $\frac{4}{5}$ = $\frac{4}{10}$,,
Total capital = £40 × 5 × 200 = £40,000;
∴ C's capital = $\frac{4}{10}$ of £40,000 = £$\frac{160000}{3}$
= £10,666 13s. 4d. Ans.

Note.—Huxley's or *Lawson's.* See advertisement columns of back numbers.

3. BRAN.—A man can run $2\frac{1}{2}$ miles in 21 minutes, and a boy can run $1\frac{1}{2}$ miles in 17 minutes; find the ratio of their speeds.

Man's rate : Boy's rate :: $\frac{2\frac{1}{2}}{21} : \frac{1\frac{1}{2}}{17}$,
:: $\frac{5}{42} : \frac{3}{34}$,
:: 5 × 17 : 3 × 21,
:: 85 : 63. Ans.

4. BRUTUS.—How many 6-lb. loaves would 80 men eat in 50 days, if 40 women ate 70 5-lb. loaves in 6 days, 2 men requiring as much as 3 women? (*Scholar.*)

2 men require as much as 3 women,
∴ 80 ,, ,, 3 × 40 ,,
= 120 women.

women		women	
40	:	120	
lbs.		lbs.	loaves
6	:	5	:: 70 : No. required.
days		days	
6	:	50	

$$= \frac{\cancel{12}^{3} \times 5 \times \cancel{50}^{25} \times \cancel{70}^{35}}{\cancel{40}^{4} \times \cancel{6}^{1} \times \cancel{6}^{1}} \text{ loaves}$$
$$= 4\frac{37.5}{3} \text{ loaves} = \underline{1458\frac{1}{3} \text{ loaves}}. \text{ Ans.}$$

5. BRUTUS.—A and B can do a piece of work in 10 hours, B and C in 12, and A and C in 15 hours; in what time could they altogether do the work, and in what time could C do it alone? (*Scholar.*)

A and B can do the work in 10 hours,
B and C ,, ,, 12 ,, ,
A and C ,, ,, 15 ,, ;
∴ A and B ,, in 1 hour $\frac{1}{10}$ of the work,
B and C ,, ,, $\frac{1}{12}$,, ,, ,
A and C ,, ,, $\frac{1}{15}$,, ,, ;
∴ 2 (A, B, and C) ,, ,, $\frac{1}{10} + \frac{1}{12} + \frac{1}{15}$,, ,,
$= \frac{6+5+4}{60}$,, ,,
$= \frac{15}{60}$,, ,,
$= \frac{1}{4}$,, ,,
∴ A, B, and C ,, ,, $\frac{1}{4} \div 2$,, ,,
$= \frac{1}{8}$,, ,, ;
∴ A, B, and C can do the work in 8 hours. Ans.

C can do in 1 hour $\frac{1}{8} - \frac{1}{10}$ of the work
$= \frac{5-4}{40}$,, ,,
$= \frac{1}{40}$,, ,, ;
∴ C can do the work in 40 hours. Ans.

6. JACK.—Give the exact date of 201,683 minutes reckoned forward from March 4th, at 6.50 p.m. (*Scholar.*)

201,683 minutes = 3361 hrs. 23 min.
= 140 days 1 hr. 23 min.
∴ Date = 140 days 1 hr. 23 min. from March 4th, 6.50 p.m.
= 140 days from March 4th, 8.13 p.m.;

From March 4th to March 31st = 27 days
,, ,, 31st to April 30th = 30 ,,
,, April 30th to May 31st = 31 ,,
,, May 31st to June 30th = 30 ,,
118 days

(140 − 118) days = 22 days;
∴ Date = July 22nd, at 8.13 p.m. Ans.

7. P. T.—One vessel *m* contains a mixture of 27 gallons of wine and 11 of spirits; another vessel *n* contains a mixture of 43 gallons of wine and 14 of spirits. Compare the strengths of the two mixtures, supposing the strength of spirits to be three times that of wine.

Strength of mixture in *m* : Strength of mixture in *n*
:: $\frac{11 + \frac{27}{3}}{11 + 27} : \frac{14 + \frac{43}{3}}{14 + 43}$,
:: $\frac{11 + 9}{38} : \frac{14 + 14\frac{1}{3}}{57}$,
:: $\frac{20}{38} : \frac{28\frac{1}{3}}{57}$,
:: $\frac{10}{19} : \frac{28\frac{1}{3}}{57}$,
:: 30 : $28\frac{1}{3}$,
:: 90 : 85,
:: 18 : 17. Ans.

8. A. W. H.—A man sells a horse, at a loss, for 40 guineas. Had he sold it for 50 guineas, his gain would have been three-fourths of his former loss. Find the cost price of the horse.

Loss + $\frac{3}{4}$ of Loss = £52 10s. − £42,
$\frac{1}{4}$ of Loss = £10 10s.,
∴ Loss = £10 10s. × $\frac{4}{7}$
= £42 ÷ 7
= £6.
∴ Cost price of horse = £42 + £6
= £48.

Note.—We believe your writing will obtain the full percentage of marks at both examinations.

9. M. R. S.—A contractor agrees to sink an artesian well on the following sums: £5 per fathom for the first 30 fathoms, (consisting of gravel only), £35 per fathom through the sand, £20 per fathom through the clay, etc., £25 through chalk. He found the thickness of the chalk to be equal to half the depth of the well, and that the sand beds were 3 times as thick as the clay. At the end of the work he received £2700 for his trouble. Find depth of well.

£25 × $\frac{1}{2}$ No. of fathoms + £35 × $\frac{3}{8}$ ($\frac{1}{2}$ No. of fathoms − 30)
+ £20 × $\frac{1}{4}$ ($\frac{1}{2}$ No. of fathoms − 30) + £5 × 30 = £2700,
£25 × $\frac{1}{2}$ No. of fathoms + £35 × $\frac{3}{8}$ No. of fathoms
− £35 × $\frac{3}{8}$ of 30 + £20 × $\frac{1}{4}$ No. of fathoms
− £20 × $\frac{1}{4}$ of 30 + £150 = £2700,
(£$\frac{25}{2}$ + £$\frac{105}{8}$ + £$\frac{20}{4}$) × No. of fathoms
− £787$\frac{1}{2}$ − £150 + £150 = £2700,
£$\frac{100 + 105 + 20}{8}$ × No. of fathoms = £2700 + £787$\frac{1}{2}$,
£$\frac{225}{8}$ × No. of fathoms = £3487$\frac{1}{2}$,
No. of fathoms = £3487$\frac{1}{2}$ ÷ £$\frac{225}{8}$
$= \frac{\cancel{6975}^{31}}{\cancel{2}^{1}} \times \frac{\cancel{8}^{4}}{\cancel{225}^{\cancel{45}}}$
= 124.
∴ Depth of well = 124 fathoms.

Note.—Your other query will appear next month.

10. H. BULL.—A tradesman induces customers who owe £750 to pay ready money, on a promise of 5 per cent. discount, who otherwise would not have paid for 6 months. At the end of 6 months he had received £947 12s. 6d. instead of £750; what was his gain per cent.?

£ £ £
$102\frac{1}{2}$: 750 :: 100 : Present worth of debts.
2 2

205 1500
41 300

= £731$\frac{29}{41}$.
£947$\frac{1}{2}$ − £731$\frac{29}{41}$ = £215$\frac{30}{328}$.
£ £ £
∴ 731$\frac{29}{41}$: 100 :: 215$\frac{30}{328}$: Gain per cent.
41 328

30000 1720
8 430
645
240000 301
800

7088
23607
= 29$\frac{207}{820}$ per cent. Ans.

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The numbers of the *Practical Teacher* for February and March, 1884, are now out of print.

Publications Reviewed.

Magnetism and Electricity, Part II. (Elementary Text Books.) **Botany,** Part III., and **Principles of Agriculture,** Book III. (Comprehensive School Series.) London: Blackie and Son.

In schools and places where they teach, a moot question is always upturning as to whether the best teachers should have charge of the younger or of the elder students. By many, the decision is made in favour of the juveniles. Their instruction seems to be a task at once the most difficult and the most important. Supposing that two teachers could be found exactly equal in knowledge and in ability to impart knowledge—a discovery as unlikely as that of the two identical grass-blades of our childhood search—we are not sure that the more resultful work would not follow from the labour of one of them as expended on young thinkers, than from that of the other upon 'children of a larger growth.'

Whatever doubt may exist as to this position in regard to oral teaching, none is possible, we conceive, upon the important question as to who should write our elementary text-books. The works upon science or literature or art, adopting our customary artificial distinctions, that are to guide the first steps of young minds along the pleasant paths should be written only by those who have the subject with which they deal at their fingers' ends. Unfortunately in too many cases the authors seem rather to keep their subject at arm's length. They write elementary text-books upon matters their knowledge of which is like the text-books. This is not always the case. Thus the excellent series of Science Primers issued by Messrs. Macmillan, the list of whose authors includes such names as Foster, Geikie, Hooker, Roscoe, is, as such a series should be, a set of works by masters of the several subjects. But, far too generally, the introductory books are of such a nature as to give inaccurate impressions at the most impressionable time. And to this censure the three booklets that we have received from Messrs. Blackie are open.

The best of the three is that on Magnetism and Electricity. Truly, it starts with the unfortunate phrase, 'Electricity is a force,' and places this misleading statement in the 'bad eminence' of italics. In the same first paragraph we have also such a loose expression as, 'Their name for amber, "electron" was given to this force.' Of course, electricity is a mode of motion, and its name is only derived from *elektron*. Two electricities are also mentioned, and the student is informed that by the electroscope he can 'see the presence of electricity'—an operation closely allied to 'seeing the wind.' The only other regrettable point in the little work is the explanation of thunder (p. 90), as only due to the echoing of sound from clouds and mountains. The important fact that the rolling of thunder is at least in part explicable by the ear receiving as a succession of sounds the results of concussions at various distances. The concussions are like the lightning-flash, their cause, practically instantaneous. The sounds, their consequence, reach the auditor one after the other because of the slow comparative speed at which sound travels. We think it is also matter for regret that the Holtz machine is not even mentioned. But, for the rest, the work is well done. The writer is evidently both a practical electrician and a practical teacher. The experiments are carefully chosen, carefully described, and, best of all, carefully gradated; that is, they follow one upon the other in a succession well arranged in an ascending order of difficulty, and leading the mind of the learner by steps that are never too long, or necessary to be retraced. The systematic arrangement of the whole work, and the judicious use therein of capitals, italics, letters, and numbers, mark the practical teacher.

The second and third of the books under consideration belong to the Comprehensive School Series. The one on botany is clearly written. Every one can understand what the author wants to say. Unhappily, much that he says is inaccurate, and more is unfortunate. It is unfortunate that the old word 'pistil' is still used. Gynæcium, though longer, is so much more meaningful. Pistil, as a botanical term, is exploded. The Samara fruit is denoted by its old-fashioned and not very intelligible synonym of 'key.' The misleading names, 'exogen' and 'endogen' are also retained. As an interesting transition case between the merely unfortunate and the actually inaccurate, we note the treatment of the perisperm of the seed on page 123. Not only is the old and bad name

'albumen' used, but the student is misled to believe that the reserve-material within plant-seeds is identical with the white of egg. More or less important errors are the partial blunder in the first two pages in regard to the inferior and superior ovary, the definition of a carpel as if it only consisted of the ovary region, and not also of style and stigma; the definition of the three layers of a plum-fruit (epi-meso-endo-carp) from carpel rather than καρπος (karpos)=fruit; the omission of the tegmen as a coat of the seed; and the statement that conifers are polycotyledonous. Surely a writer on botany for beginners should know that the conifers have, like the rest of the dicotyledones only two cotyledons or embryo-leaves, although each of the two divides after a time. The comments of the German school of botanists on the explanation of the apple as a fruit with a calyx-tube conjoined would also be worth hearing. But it is when our instructor of the young aspires to give information as to cryptogams that he is at his wildest and his worst in the matter of blunders. The sub-kingdom cryptogamia becomes, with him as guide, a class (p. 132). Fungi are a family. The exceedingly bad name 'acotyledons' is used. 'Ferns are the highest order or family of the flowerless plants.' Not only does this sentence make by implication an order and a family equivalent, whilst it treats of a group *filices*, which is neither an order nor a family, but it contains a most inaccurate statement. Two classes at least, the club-mosses and the rhizocarps, are higher cryptogams than the ferns. With the other end of the sub-kingdom the author is equally at fault. 'Lichens are the lowest form of vegetable life.' Not a word is said as to Schwendener's demonstration that lichens are not a class *per se*, and are only fungi, parasitic on algæ. And even passing over this, lichens are by no means the 'lowest form of vegetable life.' Torula and protococcus, with their allies, are in evidence against this idea. How little the author is qualified to deal with his subject may be gathered from two contradictory passages within half-a-dozen pages one of the other:—'The flowerless plants are entirely destitute of stamens and pistil, or of any organs which might correspond to them. . . . . The cells are not all alike. They are of two kinds, one sort being round, the other long or spindle-shaped. They are the actual flowers of this microscopic plant, or, at all events, they do the work which flowers accomplish in the flowering plants. The long, spindle-shaped cells represent the females, and the rounded cells the male or staminate flowers. From the striking resemblance existing between these round cells and the anthers of flowers they have been called *antheridia*. The long spindle-shaped cells are like the ovary of the pistillate flower, for they contain a sort of germ.' The only words of unqualified praise that we can give are for the good diagrams, the practical method adopted in the teaching, and especially for a very clear account of the difference between a monocotyledonous and a dicotyledonous seed (p. 118).

Elementary Text-Book of Physics. By. J. D. Everett. London: Blackie and Sons.

With what a sense of relief we turn from the three little books of which we are bound to speak thus strongly, to another issued by the same publishers. The copy forwarded us is one of the second edition. The first edition has been the delight of physical teachers and students for the last two or three years. The volume, of 316 pages, is the very model of a text-book in elementary science. The clearness of its print and the excellence of its diagrams are the least important points, notable as they are in themselves. The clearness of thought and the excellence of method far out-weigh these companion virtues. Here is a writer completely master of his subject. His mastery of all the intricacies and all the generalisations of every branch of Physics fits him for dealing with the rudiments of the subject. It seems almost an impertinence to say, that there is not a blunder from one end of the book to the other. Not only are all facts and principles given with scrupulous accuracy; they are given also in the clearest language. More than that. Only those who have had some practical experience of teaching will fully understand the remarkable skill with which Professor Everett has taken exactly the right facts and principles out of the many from which he had to choose. It is the rarest skill, this—to select from the vast storehouse of truths mechanical, thermal, electrical, precisely those that are the best, the most essential for the beginner, as giving a firm foundation for his scientific feet. It is a skill that may grow. For the difference between the first and second editions of Professor Everett's book is the outcome of an advance in the author's power of teaching. He has advantageously omitted certain paragraphs of over difficulty, and especially all that has to do with 'absolute units.' In this he has shown a wisdom that is not, we think, exactly paralleled in the greater extent to which British units have been employed. If the teachers of science themselves give way in the contest between the sensible metric system and the senseless English measures, the victory of the rational system will be long delayed. The same blunder as that made by Professor Everett is committed by the examiners of the Science and Art Department in Theoretical Mechanics. All the questions given by them in the elementary stage are most unfortunately in terms of pounds, feet, pints, and so forth. When once, with due and timely notice, the Department brings about a change in this matter, and Science and Art students know that they must learn the metric system in place of our barbarous 'tables,' and when such writers as Professor Everett refuse to have any pandering with the evil set of English measurements, the day for the consistent use of the decimal system in all scientific calculations will be at hand. That day will be the precursor, probably, of the introduction of the same simple system into ordinary usage in ordinary life. Quitting this point, on which we are, to some extent, at issue with our author, we may end by saying, that of all the elementary treatises we have seen on Physics, not even excepting the excellent work of Balfour Stewart, this is by far the best. It is at once the most complete and the most thorough. It is really a beautiful book.

Elementary Lessons in the Principles of Agriculture. By W. J. Harrison, F.G.S. Second Stage. London: T. Nelson and Sons.

Some months ago we favourably reviewed the corresponding part of this work for the first stage, and we are glad to see that the second is equally creditable to both author and publishers. The book is clearly printed and well illustrated. Its matter is well arranged and most readable. It forms a capital elementary, and yet practical, introduction to the science of agriculture.

The chemical and botanical points which are inseparably involved in the science of agriculture are clearly stated. In the former, without the aid of equations, chemical interchanges are neatly arranged in a diagrammatic form. Throughout the book we are glad to see a frequent recourse to simple experiments illustrative of the points raised.

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*** *Many Reviews are unavoidably held over.*

—o—

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Answers to Course of Arithmetic. Standards I. and II. By T. B. Ellery, M.C.P.

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The Portuguese Dictionary. By A. Elwes.

Heywood (John)—
A Junior History of England. By R. S. Pringle.
John Heywood's Paragon Arithmetical Examination Papers. Standards I. to VII. By J. S. Horn.
The Paragon Reader. No. 4.
Analysis of the Book of Joshua.
Gardiner's Explanatory Geography. Part II., for Standard III.

Hodder and Stoughton—
Oliver Cromwell. By Paxton Hood.

Letts, Son, and Co.—
The Household Magazine. Part XIV.—April.

Longmans and Co.—
A Short Table of the principal Events and Dates in the Roman and Greek History. By Rev. H. P. O. Smith, M.A.
Prairie Pictures. By J. C. Grant.
Shakespeare's King John.
Jones's Text-Book of Analysis of Sentences.

Murby (T.)—
Wormell's Lectures on Heat.
The Principles of Hygiene. By A. Carey.
Murby's Imperial Copy-Book. No. 12.

National Society (The)—
Notes of Grammar Lessons.

Nelson (T.) and Sons—
Elementary Mechanics. Second Year's Course. By W. J. Harrison, F.G.S.
Principles of Agriculture. Second Stage. By W. J. Harrison, F.G.S.
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Partridge and Co.—
John Wicliffe. By D. J. Deane.

Sampson Low and Co.—
Spiers' French Dictionary. Vols. I. and II.

Simpkin, Marshall, and Co.—
An Introduction to Chemical Analysis. By A. Barker, M.A.
A Practical Guide to German Conversation. Parts I. and II. By Karl Gengnagel, Ph.D.

Smith (Walter)—
The Student's Proper Psalms. With Notes. By the Rev. G. W. Wall, M.A.

Smith, Elder, and Co.—
The Cornhill Magazine, No. 10, for April.

Ward, Lock, and Co.—
The Universal Instructor. Part XLII.—April.

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Towards the close of the year 1860 I had an attack of low, nervous fever, by which I was greatly prostrated, and which made manifest a weakness existing in the spine. From the fever I recovered, though my physician said he feared there might have been something latent, but he hoped such was not the case.

However, early in the following year I began to suffer each morning from a high state of feverishness, which lasted many hours, and consumed my strength; upon movement my breath also became very short—and so short and rapid did it become that I can only describe the state of respiration to have been loud and hurried, the great rapidity causing the noise to be heard at a distance. Only as I remained perfectly free from movement did the above distressing effect subside, while a simple remove from my chair would at once beget the same unnatural action of every nerve and muscle. You will not wonder when I add I lost strength daily. Under these circumstances, the object, of course, of my physician was to subdue this singular state of respiration.

To attain this end I was constantly taking medicine and a variety of tonics, all of which only increased the fever, and rendered the breathing worse.

During the same year (1861) I saw several eminent London physicians, but they, with my own, were evidently quite in the dark as to the exact nature of the case. I derived no benefit whatever from their treatment; they could only say that it was not a lung affection, but one of the diaphragm.

Under the advice of my own physician I took a vapour bath, which injured me greatly, applied strong liniments, a blister and plasters, and, lastly, leeches to the top of my spine. The bleeding was not to continue for more than one hour; but, unfortunately, it was not foreseen that the very thing it was hoped it would remove was the means of preventing it from staying, and it was a day and a half before it quite ceased.

Very shortly after this I was quite laid aside, and could not move without help; constant retchings also commenced at this time. So I continued, alternately better and worse, when latterly I saw two homœopathic doctors, who said I had been both wrongly and roughly treated, and they believed it to be a case of Spinal Concussion and Irritation, and such cases, they need not tell me, were most intractable. I was not treated by either of the above, the one becoming afflicted, and the other not having confidence to make an attempt, again and again assuring my friends my case was hopeless.

But as results have since shown, my affliction, though a dark cloud, had yet a silver lining, to be discovered in due time.

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By degrees, and with the additional aid of the Belt, I have gradually and wonderfully progressed; from sitting up for a short time I can sit up the whole day, and have done so for five weeks. I was able to walk alone very soon after wearing the Belt, and can walk slowly and gently up and downstairs. I have also taken a drive without any ill results; which was a great test, considering the distress and suffering which arose on two, and the only occasions during eleven years, when I was compelled to make a change of residence, and therefore be removed.

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POSTSCRIPT.—It is a pleasure to me to be able to add, my health has been maintained up to the present time, and I can go about like those who have not been laid aside like myself.—E. M. JONES. July 1st, 1879.

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Edited by JOSEPH HUGHES.

'*Knowledge is proud that he has learned so much,*
Wisdom is humble that he knows no more.'—COWPER.

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Hygiene.

BY ALFRED CARPENTER, M.D., M.R.C.P. (LOND.),
Chairman of the Council of the Sanitary Institute.

WATER.

IT may seem superfluous to ask what is the most natural liquid to take for drinking purposes; yet some men say that they don't know the taste of water. They boast themselves upon never touching it, and they pay the penalty in due course. What shall we drink? and where shall we get the liquid from? are questions of the greatest importance to all. Danger may arise from the contamination of the sources of water supply. Sewage pollution becomes augmented in an ever-increasing ratio. It is found at each decennial census that every square mile of land in the kingdom has the average number of persons residing upon it, increased to an alarming extent. The chances of obtaining a pure water supply from its accustomed sources become all but impossible in a large number of instances in thickly-peopled districts, especially when the supply is taken from a running stream.

We will consider *Water*, before taking into account the nature of other beverages. The qualities of a good water are negative rather than positive. It is the absence rather than the presence of distinguishing characteristics which mark its purity. Its characters may be considered under three heads. (1) *The Physical;* (2), *Microscopical;* (3), *Chemical.*

1. *Physical Qualities.*—Pure water is without taste, smell, colour, or deposit. The absence of colour may be observed by looking at the water through a glass cylinder two feet long, made to stand erect upon pure white paper. If the water be heated with a few grains of caustic potass, there will be a smell developed if there is much organic impurity in it, even if there be none perceived before it was heated. It should be neutral to the action of test-paper—that is, blue litmus paper is unaffected, and reddened litmus keeps its colour.

Fill a clean Florence oil flask perfectly full with the water to be examined, and hold it up in front of a bright light. If there is organic matter in suspension in it, or if there be any living organisms floating about, they will be at once perceived. If there is any visible matter, allow it to subside, and leave it for microscopical examination. If water stands these tests successfully, unless it contains some objectionable matter in solution, it is probably fit for drinking purposes. Foreign substances which may be in suspension are not necessarily injurious, as they may consist of sand or chalk, or some other comparatively innocuous material, which may settle completely as soon as the water is at rest, the microscope will reveal their nature. Let the water to be examined be placed in a tall champagne glass; it should be carefully covered so as to keep out dust, etc., and at the end of a few hours the supernatant fluid may be drawn off by a syphon, and the sediment at the bottom transferred to a slide covered with thin glass, and placed under the field of the microscope. The nature of the deposit will be easily made out, and its source pretty accurately fixed upon by an expert. The *débris* may consist of cottony fibres, scales of epidermis, etc., (the evidence of dust,) or it may consist of particles of muscular fibre, indicative of direct sewage contamination, or there may be various matters, such as ciliated infusoriæ, bacilli, confervæ, diatoms, or algæ, indicative of living organisms, which feed and grow upon contaminations of different kinds. We may find various species of worms, spores of fungi, etc. When they are numerous the water is not potable. Water which has decided tastes should be rejected, but water free from taste may yet be very objectionable. Common salt is not tasted until the quantity in solution equals 75 grains to the gallon. Carbonate of soda requires 60 grains in the gallon before it is noted by an ordinary person, whilst one-fifth of a grain of an iron salt is at once perceived, though it is comparatively harmless. The absence of taste is not, therefore, a safe guide as to purity. The source of the water which is under examination should be fully known, whether it be from a tank, a cistern, or from a service pipe, well, stream, or lake. That impurity which may be found in one source of supply will have a different bearing from that which is derived from its presence if the supply is from a different source. The position of the source should also be known. If from a well, all the particulars regarding the well, as to its situation and relationship to houses, drains, cesspools, pumps, stables, and even cultivated gardens or other lands should be noted. The presence of chloride of

sodium in water having its sources liable to inroads from sea-water has a very different signification from that which attaches to its irregular appearance in land.

Microscopical Examination.—A good microscope with high powers is indispensable, though low powers will give much information. The deposit should be transferred from the glass in which it has been collected to the slide by means of a plain straight tube of glass, from $\frac{1}{12}$ to $\frac{1}{6}$ of an inch in diameter, without any narrowing of the point at either end. The tube is passed down to the deposit, the finger being placed upon the top end of the tube. As soon as it reaches the deposit the finger is raised for a momentary space of time, some of the deposit at once rises in the tube, and may be lifted out and then transferred to the glass slide; it should be covered at once with thin glass.

1. *Minerals*, such as sand, etc., will be known by their shapes; they are large, angular particles, often with conchoidal surfaces. Clay and marl are round smooth globules; they are unaffected by acids. If the deposit be chalk it is soluble in diluted acids with effervescence. Iron peroxide is in reddish brown amorphous masses, easily dissolving in acids.

2. *Vegetable matters.* Bits of carbon are found, decayed wood and coally particles from soot are easily made out, portions of woody fibre (Fig. 2; 5, 6, 7, 8), veins, ducts, and parts of leaves (Fig. 4; 1, 9, 12, 13), bits of cotton, linen, cells of starch, fibres from cabbages in spiral threads, fragments of paper, all indicative of water contaminated with house refuse. But algæ, diatoms, and desmids (Fig. 1; 5 to 12), with algoid vesicles, are not so injurious; they indicate water from running streams, and may be harmless.

Fig. 1.

Fig. 2.

3. *Animal products.* Bits of wool, particles of insect life, skins of water creatures (Fig. 4; 2, 3, 4, 5, 6, 10), epithelium or particles of skin from all sorts of animals, bits of muscular fibre (Fig. 4; 14). The identification of these will frequently point to the source of the contamination.

Living organisms are extremely numerous, a mere list of them would fill several pages. The wheel animalculæ and others of the *infusoria* class are plentiful. Their presence in the abstract is not hurtful, because it is probable that they are Nature's scavengers, and that they remove hurtful ingredients from the water. If they are numerous, the inference to be drawn from their presence is that there is food for them to live and multiply upon, and that that food is probably drawn from obnoxious sources. This inference would also apply to the *entomostracan crustaceans* (Fig. 1; 1, 2, 3, 4, 11), such as the water-fleas, the *tardigradæ*, or water-bears, and other kinds of tank life, *bacteria*, *vibrios* (Fig. 2; 14, 15), and microzymes, or *cacazymes* (Fig. 4; 15), as I prefer to call them, have a decided significance. They require high microscopical power to see them properly. Their presence in water is indicative of several things. There must be, for instance, organic carbon capable of decomposition; also a nitrogenous substance, which need not be organic. It may be a nitrate or nitrite of either soda, potass, or ammonia, which becomes decomposed by the growth of the living organisms. Minute quantities of a phosphatic salt are also necessary, for it has been clearly made out that all cell-growth is associated in some indefinable way with a salt of phosphorus. Oxygen must also be forthcoming, though certain of the vibrio class seem to revel most when free oxygen is absent. The common bacteria and ordinary vibrios (Fig. 3; 13), are not in themselves hurtful, any more than are the infusoria, but they indicate the proximity of putrefactive organic matter, which is most likely of a highly dangerous character. Monads or zooglææ are also found with some *rhizopods*, with *euglenæ*, *hydrozoæ*, *amœbæ*, and ova of every kind. The ova of worms and their embryos are indications of great importance and of great danger to those who use water containing them. There may be the ova of tape-worm, of the round worm, or of the thread-worm, and many other obnoxious things, and even parts of the worm themselves (Fig. 4; 8, 11). When detected they should lead to the condemnation of the water, as not fit to be used for potable purposes. Any stream in which the muddy deposit at its edges gives indication of the presence of the red-blooded worm (Nais, Fig. 4; 7, one of the annelidæ), on a warm, sunny afternoon, is certainly contaminated by the sewage of flesh-feeding animals, and no water supply for drinking purposes ought to be taken from such a source.

Sometimes the positive evidences of sewage contamination are shown by the crystals which belong to human urine (Fig. 2; 1, 9, 10, 12, 13), or epithelium,

or even blood corpuscles (Fig. 3; 4, 14), and corpuscles from other creatures may be sometimes seen (Fig. 3; 6, 7, 8, 9, 10, 11); indeed, the names of obnoxious things may be reckoned as legion.

Chemical Examination.—It is sometimes important to determine the nature of the gases which are contained in water, though the process is generally omitted by professed analysts. N., O., and CO_2 need only be looked for, as if hydrogen sulphide or carburetted hydrogen are present, their presence will be sufficiently demonstrated by the smell, and enable any one to condemn the water as unfit for ordinary drinking purposes; and if ammonia exists there is an alkaline reaction. The ordinary proportions of O, N, and CO_2 in the ordinary supply should be ascertained, and departures from those proportions observed. The three gases generally co-exist. Natural water contains a larger proportion of O compared with N, than is present in the atmosphere. This fact is used to show that the air is a mixture of gases, and not a chemical compound. The quantity of oxygen present in a pure water exceeds 30 p.c., as against 21 p.c. of the gas in the atmosphere. If water be boiled so as to drive off all the contained gases, and if it be then

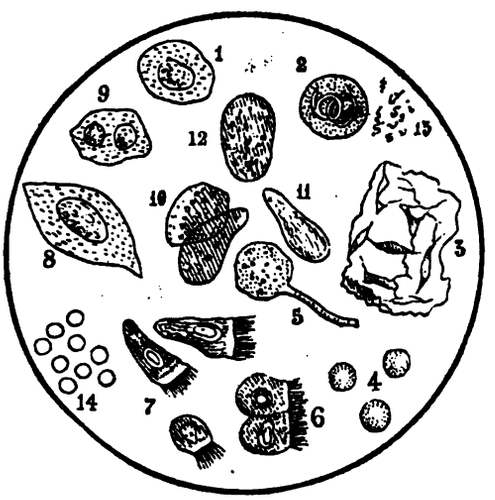

Fig. 3.

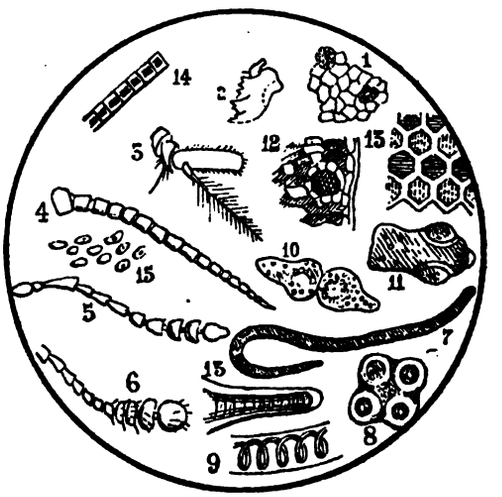

Fig. 4.

shaken up with a measured proportion of common air, in which the gases normally exist as about 4 N to 1 O, it is found that the proportion dissolved is as 1·8 N to 1 O, scarcely half the quantity of N as found in the air being dissolved by the water. This latter gas is not much interfered with by impurities, the quantity being nearly the same in pure as in impure water, but when it is found that O is decreasing and CO_2 increasing it is evident that the O is being used for oxidising purposes, and that there is C in the water, which must be derived from the decomposition of organic compounds. The presence of CO_2 is easily shown by exposing the water to bright sunshine in a covered glass, the CO_2 attaches itself to the sides of the glass. This, however, is not positive proof, for if the water has been drawn from a service pipe in which air has been forced into the water by extreme pressure, the pressure being removed, allows the absorbed air to escape from the water, and it attaches itself to the glass in a manner similar to that of CO_2. It is not difficult to clear the gases from a given quantity of water if proper apparatus is at hand. It requires a mercurial trough and all the usual apparatus. The collected gases are then passed through a solution of KO, by which the CO_2 is absorbed and the consequent increase of weight is noted. It is then passed through potassium pyrogallate, by which the oxygen is arrested; the residue being nitrogen. The *chemical examination* of water is said to be either qualitative or quantitative. The processes are intricate, and would require more space than can be devoted here to their description. I shall only give some general directions which may enable the reader to determine that a given water is a suspicious water, and ought not to be used as potable water. It will be therefore as to quality of impurity and not as to quantity that our observations will extend.

The reaction on *litmus paper* has been already mentioned. If *turmeric paper* be browned, the water is alkaline; if it be due to NH_3, the alkalinity disappears on boiling; if it is not so removed, there is a fixed alkali, as soda, in the water. If the NH_3 is free, a test liquor called *Nessler's solution* gives a colour or a precipitate according to the quantity. If the water be boiled with certain reagents, as potash and permanganate of potash, the albumenoid matters which may exist in solution in the water are broken up; the nitrogen present in the compound is made to form an ammonic salt, and if then the water be Nesslerised, as it is called, it gives a result which is assessed according to the tint of brown colour which is produced in the liquid acted upon. This reaction is not a safe guide, for the nitrites and nitrates produced by the sewage of former ages, and which are now innocuous, are made to appear as evidence of a previous sewage contamination, and assessed as if now dangerous. If the sewage contamination is of a late date, there are other means which are more reliable and safer guides. We may look for chlorine and phosphoric acid (H_3PO_4), whilst the changes which may arise in the quantities of HNO_3 and H_2SO_4, or the presence of metals which are foreign to the usual water of the district, are the best guides as to contamination; though I am not inclined to depreciate the value of the Nessler's test when the ordinary states of the pure water of the district are well-known.

Chlorine is detected by nitrate of silver, the water

being first acidified by a few drops of nitric acid (HNO_3); there is a white precipitate, becoming darker by the continued action of light; one grain per gallon gives a slight haze, whilst four grains show a marked degree of turbidity, becoming in due course a decided precipitate; but ten grains give a precipitate immediately. All hard water contains from one to two grains of chlorine per gallon. It is the difference in quantity in the water under examination from the usual amount which is the guide as to contamination, for if the specimen has not been affected by tidal waters, it indicates the certainty of sewage contamination when the quantity of chlorine in a given specimen shows signs of irregularity and of increase over the normal amount.

(*To be continued.*)

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The New Class-Subject, 'Elementary Science.'

(*What to teach, and how to teach it.*)

BY RICHARD BALCHIN.

IN the syllabus of work for Standard IV. which appeared in last month's issue of this magazine, it will be seen that we start with a description of some of the common elements and compounds. It is almost impossible to advance in any path of knowledge without at least *some* chemistry.

Apparatus is here required. For the twenty-five years during which I have taught boys 'elementary science'—that is, up to the present time—I have had to furnish apparatus at my own cost, and have often been sneered at for my pains. *Now*, however, we live in happier times, and the School Board for London will make a special grant of apparatus to those teachers who desire to take up science in their schools. It may be interesting to see the list which the Board granted for the use of Gloucester Road School, and which grant has been repeated in the case of my present school at Peckham Rye:—

1 pneumatic trough; 3 stoppered gas-jars; 2 sets of glass beakers; 2 glass funnels; 2 Woulff's bottles; 2 retorts; 4 lbs. glass tubing; 100 test tubes; 2 dozen glass-stoppered bottles; 2 spirit lamps; 1 set of porcelain saucers; one set of enamelled iron saucers; 2 retort stands; 2 test-tube stands; 1 Bunsen's burner and 12 feet of rubber tube; 1 pair of scales; 1 set of cork perforators; an assortment of corks; 1 pair of pliers: 1 file; 2 sets of filter papers; iron and copper wire; pestle and mortar; 2 deflagrating spoons; one pint each of nitric, sulphuric, and hydrochloric acid; 2 lbs. chlorate of potash; ¼-lb. black oxide; 2 lbs. granulated zinc; phosphorus; sulphur; iodine; litmus; sodium; etc.

Before taking the lessons proper to the course it will be necessary to explain some of the apparatus.

LESSON 1.—THE PNEUMATIC TROUGH. (*Note.*—I need no longer give a list of the objects required to illustrate the lesson. This information may be gathered from the notes.) While in Standard III. the boys learned that by breathing we effected a change in the air. We wish to examine our breath and compare it with the ordinary air to discover the nature of this change. Ask the boys how they would obtain a gas-jar full of 'breath.' So lead to the dual operation by which this is done, *i.e.*: (1) We get rid of the *air* in the jar by filling the same with water. (Two things cannot occupy one and the same space at the same time. The pressure of 15 lbs. to the square inch on the surface of the water *outside* the jar keeps the water up *inside*.) (2) By means of a bent tube we breathe up into the jar so as to allow the breath to displace the water. Let one of the boys do this. Now place two jars side by side—one full of ordinary air, and the other full of expired air, *i.e.*, 'breath.' Show by dipping into each jar a lighted taper, that there *is* a difference in the two airs or gases. By this and other experiments, the 'use' and 'principle of action' of the pneumatic trough may be illustrated. Show how a very cheap and simple pneumatic trough may be constructed with a pail and two bricks. (Two lessons will probably be found necessary for this subject.)

LESSON 2.—THE SPIRIT LAMP. Show the parts of the lamp. Show the boys how to make a very cheap one. Get an empty penny ink-bottle with a cork, through which passes a piece of tin bent into the form of a short tube for the wick. This is described and illustrated on page 51 of the Science Reader for Standard IV. (Hughes).

Fill the lamp with methylated spirit, and light it. Show and explain the observed facts in the following order:—(1) Spirit is very *volatile*, *i.e.*, soon changed to its vapour; the heat of the hand sufficient to effect this. (*Spiritus* (Lat.) = breath.) (2) This vapour is inflammable. To show this, fit a cork into a large test-tube, pass a piece of pointed glass tube through the cork, heat the spirit, and light the vapour issuing from the point of the tube. (3) By capillary attraction the spirit rises up the wick. (4) The match first applied gives the heat sufficient to vaporise the spirit and then to inflame the vapour.' (5) The heat of the spirit-flame continues the processes of evaporation and inflammation.

(*Note.*—There is quite enough material here for two lessons.)

LESSON 3.—THE STRUCTURE OF FLAME. (For the subject-matter of this, and the following lesson on the Bunsen burner, I almost feel that I need simply refer the reader to pages 47 to 50 of Tyndall's 'Heat considered as a mode of Motion;' anything more charming than this description I have never read. As, however, some teachers may not have the book by them, I will give, in the usual manner, the outline of the lessons.)

To illustrate the structure of flame, I have made a very thick candle in the way following. Procured 2 lbs. of ordinary 'dips.' Put them all into an iron saucepan and melted them. Took the wicks out of the melted fat, and twisted them together to form one large wick. Placed this wick upright in an empty tin can, such as coffee or preserved lobsters are sold in; fastened the wick top and bottom. Poured the melted fat into the tin, so as to fill the space around the upright wick. Let the whole cool for a day or two. Cut out the bottom of the tin, and then pushed out my 'giant candle,' as the boys called it. (*En passant*—This was all very satisfactory, except that at home I occasionally heard mutterings about the potatoes tasting of tallow candles. But, of course, science, etc.)

Get the large candle well alight and quite protected from draughts. Pass down into the middle of the flame one end of a piece of glass tube. Some gas

passes up the tube and can be lighted at the other end. This gas came from the interior of the flame; therefore the flame seems to be a hollow case enclosing inflammable vapour. Test this in another way, by letting down from above on to the flame, as far as the middle of it, a sheet of clean paper. The paper is burnt or scorched in ring-form, in the centre of which the paper is unconsumed. The 'vapour' is the vapour of tallow. Show that tallow may be converted to vapour by heat, and that this vapour is inflammable. [Heat some melted tallow in a test-tube, as described in the case of spirit, in a previous lesson.] (Should not at present use the term 'hydro-carbon' for this vapour, but simply 'fat-vapour.' Nor would it be advisable to speak of the 'oxidising' or 'reducing' flame.)

After these preliminaries, the observed facts will be taken in the following order: 1st, the tallow melts; (2) the liquid fat rises up the wick; (3) the fat is changed to its vapour, which fills the interior of the flame; (4) the vapour burns.

(*Note.*—This lesson should be repeated after the boys have taken up the subject of oxygen, hydrogen, carbon dioxide, and the composition of air and water. *Then* the nature and products of combustion may be explained, and the lesson upon the Bunsen burner given.)

LESSONS 4 TO 10.

Matter and elementary bodies. Oxygen. Carbon. Hydrogen. Composition of water. Nitrogen and the composition of air. Carbonic acid.

The subject-matter of these seven lessons is given with sufficient fulness on pages 7 to 30 of the Science Reader for Standard IV. and on pages 86 to 140 of that for Standard V. I particularly call attention to the illustration on page 140 of the latter. It would be well to make a large 'wall' picture of this for continual reference. I may perhaps mention, in connection with the lesson upon 'oxygen,' that we are in the habit of performing an experiment which shows in a striking and interesting manner the fact that this gas is a supporter of combustion. As far as I know, the experiment is not described in any text-book.

I have on the table a glass vessel holding about two gallons of water. A small aquarium will answer the purpose. A small taper is fixed in a piece of cork and floated on the surface of the water. A large beaker or tumbler is then inverted over the lighted taper, and pressed down to the bottom of the vessel of water. The taper consuming the oxygen of the air begins to burn dimly. I then, by means of a glass tube from an oxygen generator (*i.e.*, heated potassium chlorate, etc) introduce a fresh supply of oxygen to the inverted tumbler. The consequent brightening up of the taper, buried as it is in the vessel of water, forms an exceedingly beautiful object.

Any additional matter which the teacher may require for this part of the subject will be found in the Chemical Notes by Dr. Aveling, as they appear from time to time in this magazine.

LESSONS 11 TO 14.

Distinction between chemical and physical properties. Weight. Attraction of cohesion and the three states of matter, *i.e.*, solid, liquid, and gaseous. Indestructibility of matter.

Here, again, I feel that to re-state the substance of these lessons would be a needless repetition. I therefore refer the teacher to Chapter IV. of the Second Science Reader.

(To be continued.)

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Chemistry of the Non-Metallics.

BY EDWARD AVELING, D.SC. LONDON.

[This series of articles, whilst dealing with the subjects required by the University of London for the Matriculation Examination and with those required at the Elementary Stage of the Inorganic Chemistry (Branch X.) Science and Art Department, is intended as a practical guide to the philosophical and systematic study of the non-metallics.]

CHAPTER III.—(*continued.*)

EXAMPLES ON THE PREPARATION OF HYDROGEN FROM ZINC AND SULPHURIC ACID.

(*For Solution.*)

(5) Required 6 grams hydrogen. What weight of zinc must be taken? ... ... 195 *grams.*

(6) 7 grams sulphuric acid are poured on a mass of zinc. How much of the metal is dissolved? ... $4\frac{9}{49}$ *grams*

(7) $\frac{1}{2}$ gram hydrogen is evolved. What weights of metal and acid have been used? $16\frac{1}{2}$ *gms. of zinc,* $24\frac{1}{2}$ *gms. acid.*

(8) 8·05 grams of zinc sulphate are formed. What weight of zinc has been dissolved? What weight of hydrogen is evolved? ... ... $3\frac{1}{2}$ *grams and* $\frac{1}{20}$ *gram.*

Lastly, so far as this particular equation is concerned, we may consider the question of volumes. As in dealing with weights we had to study certain essential preliminaries, so in dealing with volumes we have to master a general principle.

For its understanding a knowledge of thermometers, and of the laws of barometric pressure is necessary. A thermometer, θερμος (thermos) = heat, μετρον (metron) = measure, is a register of temperature or a register of the condition of bodies in regard to sensible heat. The ordinary thermometer is a closed glass tube, with a bulb at one end. It is partly filled with the liquid metal—mercury. Above the mercury is a vacuum. Plunged in melting ice the mercury stands at a certain level. This is marked on the glass, and called the freezing point of water. Plunged in the steam of boiling water, the mercury rises to and stands at another level. This is marked on the glass as the boiling point of water. The space between these two marks is divided into a certain number of equal spaces, called degrees.

In the scientific thermometer, the scale of Celsius, the Swede, is used. On this scale 0° is written opposite the level of the mercury, when the instrument is placed in melting ice, 100° opposite the level of the mercury when the instrument is placed in the steam of boiling water. Briefly, the freezing point is 0°, the boiling, 100°. The space between is divided into one hundred equal parts. And this scale is called the Centigrade (centum = one hundred, gradus = a degree).

Two other scales are occasionally used—the Fahrenheit which has for freezing point, 32°; for boiling, 212°. The fixed points on the Réaumur scale are 0° and 80°.

Sometimes it is necessary to convert the degrees registered on one scale into their equivalents on another. This is done by the following plan:—

(i.) *To turn a certain number of degrees expressed on the Réaumur scale into the equivalent expression on the Centigrade scale.*

From freezing to boiling point on Réaumur scale = 80 spaces.
" " " " " " Centigrade " = 100 "

80 spaces on the Réaumur scale correspond with 100 on the Centigrade.

1 space on the Réaumur scale corresponds with $\frac{100}{80} = \frac{5}{4}$ on the Centigrade.

of shop? Name some. What is a shop? The answer will most likely be, 'A place where we can buy different things.' Can we buy all things at the same shop? No, we buy different things at different shops.

II. *Description.*—Can you tell me what kind of a place a shop is? It is like a house. I should say it is a part of a house. Which part of a house is it? It is the bottom part of a house. Is there nothing underneath the shop? Yes, very often the kitchen is under the shop, or else there are cellars. What is there over the shop? There are rooms. Now what is the shop like? Yes, it is like a very large room. But do you know how it is different to a room? It has a very large window. Do we ever have such large windows to our rooms? No. Generally all the front of the shop is a window. How do you get into the shop? By the door. Where is the door? By the side. Yes, but sometimes the front of the shop has two windows; then where is the door? In the middle. What do you generally see outside shops, over the door or window? We see a name. Whose name is it? The man's whose shop it is. Yes, he generally has his name, and sometimes, too, the kind of shop he keeps. If a man sells bread, what would he have over his shop? Baker.

Now we will go into the shop. How shall we get in? By the door. What shall we see when we get in? The counter. What is the counter like? It is something like a long table. There is one difference between the counter and a table; what has the table that the counter has not? It has legs. What has the counter instead of legs? A piece of wood all along. Do you know what is the other side of the counter? Generally drawers, sometimes only a cupboard. Now if the counter were made exactly like a table, with legs, the shop people would not be able to put anything under it, because it would look so untidy, therefore it is all covered in with wood. What is the use of the counter? To put things on. Where does the master of the shop stand? Behind the counter. Where do you stand when you go into the shop? In front of the counter.

There is very often one particular drawer in the counter, do you know the use of it? The man puts the money into it. Do you know what it is called? The till. What is the use of the till? Is the drawer always opened for the money to be put in? No, sometimes it is dropped in through a hole in the counter. The till is generally kept locked. Why?

Now, if you look round a shop, what do you see in it besides the counter? Yes, there are generally a great many shelves. What is the use of these shelves? Do you ever see anything else in shops? Very often there are chairs for the people who go in to buy to sit on. Do you know what the master of the shop calls the people who go in to buy? His customers. And what do we call the master of the shop? The shopkeeper. Then some shopkeepers put chairs in their shops for their customers.

The teacher might here let the children describe any special shop, *e.g.*, some shops have a counting-house—some have hooks and no shelves (butcher's)—the peculiarities of the fishmonger's, the chemist's, etc., etc.

You told me that shops have large windows, do you know why this is? To make the shop light. Yes, and there is another reason. Do you like to look in shop windows? Why? Because of the pretty things in them. Who puts these pretty things in the window? Why? To make people look in and see what nice things he has to sell. The shopkeepers like large windows so that they can put a great many things in them, and make them look as pretty as possible.

When you go to buy anything for your mother, what does she give you? Some money. To whom do you give it? To the shopkeeper. What does he give you? Perhaps some sugar or tea—indeed whatever you ask him for. What does he do with these things before he gives them to you? He wraps them up in paper. Yes, and before that what does he do? He weighs them. What must he have in order to weigh them? Scales and weights. If you go to buy milk, do you have it weighed? What does the milkman do? He measures it. If you go to buy calico, what does the man do with it? He measures it. Is that measure the same as the one used for measuring milk? No, the one is a kind of mug, the other is a long measure. Now we have found out that some shopkeepers use scales and weights and others use measures.

Now there is one thing that people who go to buy at shops ought to be very careful about. Supposing Mary's mother gave her sixpence and told her to go and buy a pound of sugar, what would she have to bring back to her mother? Sugar. Yes, and something else besides sugar. Some money. Do you know how much money? Threepence. What do we call that threepence? The change. Then Mary would have to bring back the sugar and the change. If her mother only gave her threepence, what would she have to bring back? Only the sugar, there would be no change. Then when you go to buy, you must be very careful about the change, and take care not to lose it going home.

There is still another thing I want to ask you. When your mother sends you for some bread, where will you go? To the baker's. And if she sends you for tea? To the tea-grocer's. And for potatoes? To the green-grocer's. And for soap? To the oil-shop. Now when your mother sends you for anything, you must first think to what shop you have to go to get it, so that you do not go to the wrong shop. It would be rather silly to go to the butcher's and ask for some bread, or to the baker's for some meat; wouldn't it?

III. *Summary.*—A shop is a place where we buy different things.

The owner of the shop is called the shopkeeper; the people who buy are called the customers.

The shop has a large window, sometimes two. It has a counter, shelves, scales and weights, or measures.

LESSON—THE BAKER.

Apparatus: Some flour, yeast, salt, water, wheat. A pan for mixing flour, yeast, and water. Some 'sponge' and dough. Picture of baker.

I. *Introduction.*—The children should be questioned on what they had for breakfast. Ask them if they know who makes the bread? The children should then repeat, 'The man who makes bread is called the baker.' Does the baker make anything besides bread? Yes, he makes buns, cakes, biscuits.

II. *Bread making.*—I have all the things on the table used to make bread. I want you to look at them and tell me their names. The teacher, pointing to some flour, asks, What is this? and this? You do not know? Well, I will tell you. We call this yeast. Water and salt should then be pointed to and named. Now tell me all the things used to make bread. Flour, yeast, salt, and water. Who can tell me from whence we get flour? From wheat. Here is some wheat, is it like the flour? No. What has to be done to it to make it into flour? It has to be ground.

Now, suppose we are going to make bread, what must we get ready first? A pan, or something to hold the different things. Well, here is a pan; you see what I put into it. Some flour. Yes; and now what have I put? Some water. Feel this water; what do you notice? It is warm. What am I doing now? Mixing the flour and water. What does it look like? Batter. For what does your mother use batter? For making puddings, and sometimes she dips fish into batter before she fries it. Now see what I put into this batter. Some yeast. The baker mixes flour, water, and yeast just like this, and then he sets it aside in a warm place for six or eight hours. This he calls 'setting the sponge.'

I have some 'sponge' here that has been kept for some time; is it like it was when it was first mixed? No, it is much larger—we say it has risen. Have you ever seen anything that has risen? Yes, your mother sometimes makes cakes, and when they have been in the oven a little while, they begin to rise. Now you see that is what the sponge does: it is left in a warm place and it rises.

What does the sponge look like? Yes, it is very much like the yeast.

The children should now compare the sponge with some bread; they will see that it is too thin to make bread.

How can you make it thicker? What does your mother do if she puts too much water with her pudding? She has to add more flour. Very well, this is what the baker does. He puts some flour—much more than he used for the sponge—into a wooden trough; he mixes a little salt with it. He then mixes some warm water with the sponge, and pours it into the flour in the trough. The whole is then mixed together and kneaded into dough. What is meant by kneaded? This dough is then allowed to stand in a warm place for several hours, and at the end of this time it will have risen just as the sponge did. This dough is now kneaded again and left to rise again, then it is quite ready to make into bread. Here is some dough. What can you tell me about it? It is soft and white, much firmer than the sponge. This is now ready to be made into bread. What must the baker do with it? He must cut it into pieces. Yes; and he must weigh all these pieces to see that they are the same weight. Why must each piece of bread be weighed? Because every one wants the same amount for his money. After these pieces are weighed, they are made into different shapes. Tell me some of these different shapes. Bricks, squares, cottages, coburgs—these are all loaves. The whole number of loaves made at the same time is called a *batch*. When the loaves are made, what has to be done to them? Yes, they must be baked. They are allowed to stand for a little while, and then they are put into a very large oven and baked. The loaves are put into the oven and taken out with a peel. This should be described. Why cannot the baker push the loaves in with his hand? He would get burnt. Why is it necessary that the peel should be so long? Because the oven is so large.

Which part of the bread did we make? The sponge. Could we make a loaf of bread during our lesson? Why not? Because the 'sponge' has to stand a long while, and the dough also, before it can be made into loaves. Then, altogether, you see it takes a long time to make bread. When do we want new bread? In the morning. When do you think the baker makes the bread? Yes, he has to work all night in order to get the bread out of the oven by the morning. When must he go to bed?

III. *Summary.*—This should be written on the black board as the lesson proceeds:—

The man who makes bread is called the baker.
Bread is made of flour, water, yeast, and salt.
The baker first makes the sponge.
The sponge mixed with water is poured into some flour, with a little salt in it; this is kneaded into dough.
The dough is cut and weighed, and made into loaves.
These loaves are baked in a large oven.
The baker uses a peel.

(To be continued.)

—o—

UNIVERSITY OF LONDON.—At the annual meeting of the Convocation of this University, held at Burlington Gardens, on Tuesday, May 13th, a resolution was adopted to the effect that an examination of less difficulty than the Matriculation should be established by the University to encourage and assist pupils under sixteen years of age—both boys and girls—of secondary schools of all grades, to proceed to the Matriculation and Degrees Examinations. The Examination will be held simultaneously in London, and at certain provincial centres, the obligatory subjects for a pass being (1) English; (2) some other Language; (3) Mathematics, and (4) Science.

ANSWERS TO

Pupil Teachers' Examination Papers.

APRIL 26TH, 1884.

FIRST YEAR.

Pupil Teachers at end of First Year.

Three hours and a half allowed.

Arithmetic.

MALES.

1. Define the G.C.M. and L.C.M. of given numbers; and find the G.C.M. and L.C.M. of 792, 528, and 1232.

The G.C.M. of two or more numbers is the greatest number which will divide them without a remainder.

The L.C.M. of two or more numbers is the least number into which they will divide without a remainder.

528)792(1
528
264)528(2
528
264)1232(4
1056
176)264(1
176
88)176(2
176
G.C.M. = 88

11 | 528, 792, 1232
8 | 48, 72, 112
3 | 6, 9, 14
2 | 2, 3, 14
1, 3, 7
11 × 8 × 3 × 2 × 3 × 7
= 11088 L.C.M.

2. Divide the product of 37·5, 2·08, and ·06, by ·00005625; divide also 8·1 by ·0063 until the figures recur.

37·5
2·08
3000
7500
78·000
·06
·00005625)4·68000000(83200. Ans.
45000
18000
16875
11250
11250
00.

·0063)8·1000000000(1285·714285. Ans.

3. Express $\frac{3}{8}$ of £2·625 − 2$\frac{1}{2}$ of 1·375 shillings as the fraction of a guinea; and find in £ s. d. the value of 4·15625 guineas.

$\frac{3}{8}$ of £2·625 − 2$\frac{1}{2}$ of 1·375s.
21s.
$= \frac{\frac{3}{8} \times \frac{21}{8} \times \frac{20}{1} - \frac{15}{8} \times \frac{11}{8}}{21}$
$= \frac{\frac{441}{16} - \frac{77}{16}}{21}$
$= \frac{\frac{364}{16}}{21}$
$= \frac{364}{336}$. Ans.

guineas.
4·15625
21
s. 87·28125
12
d. 3·37500
£4 7s. 3$\frac{3}{8}$d. Ans.

4. A cistern of water lost ·12 of its contents by leakage, then 26 gallons were drawn off, and it was then three-fourths full. How many gallons did it contain at first?

Total amount leaked and drawn off = $\frac{1}{4}$ = ·25
∴ ·25 − ·12 = ·13, amount drawn off.
And number of gallons it held

galls.	galls.
·13 :	1 :: 26 : x

$\frac{26}{·13}$ = 200 galls. Ans.

FEMALES.

1. Make out the following bill and receipt it; how much change out of a £5 note?

3½ cwt. of coals at 10½d. a cwt.
13 lbs. of cheese at 7¾d. per lb.
2¾ lbs. of tea at 3s. 4d. per lb.
17 lbs. of sugar at 5½d. per lb.
3½ yds. of flannel at 1s. 11½d. per yd.
29 yds. of calico at 10¾d. per yd.

London, April 26th, 1884.

Mrs. Dyer.

Bought of Henry Wild.

	£	s.	d.
3½ cwt. of coals at 10½d. per cwt.	0	3	0¾
13 lbs. cheese at 7¾d. per lb.	0	8	4¾
2¾ lbs. tea at 3s. 4d. per lb.	0	9	2
17 lbs. sugar at 5½d. per lb.	0	7	9½
3½ yds. flannel at 1s. 11½d. per yd.... ...	0	6	10½
29 yds. calico at 10¾d. per yd.	1	5	11¾
	£3	1	3

Received same time £3 1s. 3d.
Henry Wild.

Change = £5 − £3 1s. 3d. = £1 18s. 9d. Ans.

2. Find, by practice, the cost of 29 acres 3 roods 5 poles at 100 guineas per acre.

100 guineas = £105.

	£	s.	d.		
2 r. = ½ a.	105	0	0		
			29		
	3045	0	0	= value of 29 acres.	
1 r. = ½ of 2 r.	52	10	0	= ,,	2 roods.
5 p. = ⅛ of 1 r.	26	5	0	= ,,	1 rood.
	3	5	7½	= ,,	5 poles.
£	3127	0	7½	= ,,	29 a. 3 r. 5 p. Ans.

3. What will be the cost of 987 cattle at £28 16s. 10½d. each?

	£	s.	d.		
10s. = ½ £	987	0	0	= value at £1	each.
			28		
	27,636	0	0	= ,,	£28 ,,
5s. = ½ of 10s.	493	10	0	= ,,	10s. ,,
1s. = ⅕ of 5s.	246	15	0	= ,,	5s. ,,
6d. = ½ of 1s.	49	7	0	= ,,	1s. ,,
4d. = ⅓ of 1s.	24	13	6	= ,,	6d. ,,
½d. = ⅛ of 4d.	16	9	0	= ,,	4d. ,,
	2	1	1½	= ,,	½d. ,,
£	28,468	15	7½	= ,,	£28 16s. 10½d.

4. What is the least number which, when divided by 12, 20, 30, or 54, shall leave as remainder 4?

No. required = L.C.M. + 4.

2 | 12, 20, 30, 54
3 | 6, 10, 15, 27
| 2, 10, 5, 9

2 × 3 × 10 × 9 + 4 = 544. Ans.

Grammar.

MALES AND FEMALES.

1. *Alas!* what *boots it*, with incessant *care*,
To tend the *homely*, *slighted* shepherd's trade,
And *strictly meditate* the thankless muse?

Analyse the above passage, parsing the words in italics.

2. What English terminations do you see in it? and mention other words with similar terminations.

SUBJECT.	PREDICATE.	OBJECT.	EXTENSION.
It, to tend the homely slighted shepherd's trade, and strictly meditate the thankless muse with incessant care.	boots	what	

Alas—interjection, expressing sorrow.
boots—reg. trans. verb, act., ind., pres., 3rd sing., agreeing with its nom. 'it.'
it—pers. pro., neut., sing., 3rd., nom. to 'boots.'
care—abs. noun, neut., 3rd sing., obj., gov. by 'with.'
homely—adj. of quality, qual. 'trade.'
slighted—partl. adj. of quality, qual. 'trade.'
strictly—adv. of manner, mod. 'to meditate.'
meditate—reg. intrans. verb, act. inf. pres., used as abs. noun., neut., sing., nom. in apposition with 'it.'

2. The English terminations are :—

-ly in *homely*; *-ed* in *slighted*; *-ly* in *strictly*; *-less* in *thankless*.

Other examples of similar terminations are :—bodily, godly, ghastly; wretched, new-fangled, ragged; homeless, houseless, fatherless.

3. Mention, with examples, some common terminations of adverbs.

-ly, as—wilfully, seemingly, purely, badly.
-ling, *-long*, as—headlong, sidelong, darkling.
-ward, *-wards*, as—backward, forward, inwards.
-wise, *-way*, *-ways*, as—lengthwise, straightway, always.
-meal, as—piecemeal.
-ther, as—hither, thither.
-se, *-es*, *-ce*, as—else, besides, hence.
-ere, as—here, there, everywhere.

Geography.

(*Answer either Q. 1 or Q. 2, not both.*)

1. Taking the city of Chester as a centre, describe the natural features of the country, the chief towns, and chief employments of the people, within twenty miles on every side.

Illustrate by a map, showing the courses of the Dee and the Mersey.

The city of Chester stands in the midst of a flat district watered by the rivers Dee and Mersey, both of which enter the Irish Sea by wide mouths or estuaries. That of the Mersey is navigable for the largest vessels, but that of the Dee is silted up with sand for many miles, and is only navigable for small boats. The south-western part of the district extends to the hills of North Wales, famous for their beauty. To the north, on the banks of the Mersey, are Liverpool and Birkenhead, engaged in commerce and shipbuilding. Widnes manufactures chemicals, and Warrington, iron. At Crewe are large engine works, and at Nantwich, Sandbach, and Northwich are large salt mines. Oswestry is a market-town, and has trade in agricultural produce, while Wrexham and Ruthin manufacture woollen goods, and Flint and Denbigh have mines of iron, coal, and stone. The county of Chester is agricultural, and cheese of fine quality is made, and cattle are reared in large quantities, both occupations finding employment for many people. Chester itself is an ancient city, noted for its walls and antiquities.

2. Describe, as you would to children, the position of London, Bristol, Liverpool, Glasgow, and Dublin; and say which of these towns are best placed as seaports. Give full reasons for your answer.

London stands on the River Thames, about sixty miles from its junction with the North Sea.

Bristol stands near the mouth of a small river called the Avon, where it joins the channel known by the same name in the south-west of England.

Liverpool is on the north side of the wide estuary of the Mersey, which separates Lancashire from Cheshire.

Glasgow is about twenty-five miles from the mouth of the River Clyde, which enters the Firth of Clyde on the west coast of Scotland.

Dublin is on the east coast of Ireland, and stands on the Liffey, which flows into Dublin Bay.

Liverpool and London occupy the best positions as ports. London is at the terminus of all the main lines of railway, close to an immense population, from which it gets its exports, and which serves as a ready market for imports. The river is always navigable for the largest vessels. Liverpool is near the vast populations of Yorkshire and Lancashire, and is thus well situated for getting and receiving cargoes. It is easy of access from America, with which we trade largely.

3. Draw a full map of Victoria Colony, showing the courses of the Murray, and its tributaries, and the other physical features of the Colony.

N.B.—*Insert the lines of latitude and longitude.*

History.

1. Compare the Britons with the Romans at the time of their first invasion of this island.

The Britons in the southern part of the island were somewhat civilised before the advent of the Romans. They had much of the spirit which characterises them now, Cæsar coming to punish them for helping their Gallic neighbours against him. They tattooed their bodies, but wore garments of skin and wool, and were armed with shields, javelins, and short swords. They tilled the ground, growing corn of different kinds, but had no fortresses, their towns being of rude huts surrounded by a ditch and stockade. Those of the northern part of the island were much less civilised, living upon their flocks or by hunting, and inhabiting caves as well as making themselves rude huts.

On the other hand, the Romans were trained soldiers, belonging to the most martial and powerful nation in the world. They were acquainted with arts and sciences, and the comforts and luxuries of life, looking upon all who did not belong to them as savages and as enemies. They were brave, but revengeful and cruel to those whom they conquered. Wherever they went, however, they carried with them their arts and resources, and left the countries better than they found them.

2. Who were the Picts and Scots? What measures is Vortigern said to have taken to stop their inroads?

The Picts are believed to have been the remnant of the Caledonians, the first-known inhabitants of Scotland. The Scots were a tribe who had crossed from Ireland, which was for centuries called Scotia.

Both tribes were warlike and savage, causing considerable trouble to Roman, British, and Saxon rulers of Britain.

Vortigern, a British prince, was unable to fight successfully against them, and called in the Jutes, under Hengist and Horsa, to his aid. By these means they were driven back, but the Jutes established themselves in Britain, Thanet being the reward given them by Vortigern.

3. How did Alfred the Great come to the throne? Sketch his character and career.

Alfred was chosen king unanimously by the Witan. He was born at Wantage, in Berkshire, and at twenty-two became king in preference to his brother's children. He fought against the Danes till compelled to hide in Athelney, 878. Emerging thence, he defeated them at Ethandune, their leader becoming vassal to Alfred, and ruling the eastern, while Alfred ruled the western part of the island. As the treaty then made was kept by the Danes, Alfred turned his attention to improving his kingdom. He made wise laws, encouraged trade, built ships and schools and churches. He died in 901, loved and revered by his people, for although he was harsh in the earlier years of his reign, he became less so as the troubles of his kingdom decreased. He was an able ruler, a brave warrior, a good scholar, and a pattern of industry and devotion. He very justly acquired and deserved the epithet of 'Great.'

Composition.

Write from memory the substance of the passage read to you by the Inspector.

In this part of the desert there is not the slightest sign of road or track, but the camels never fail to choose the right line. By the direction taken at starting they know the point for which they are to make. There is always a leading camel (generally, I believe, the eldest) who marches foremost, and determines the path for the whole party. When it happens that no one of the camels has been accustomed to lead the others, there is very great difficulty in making a start; if you force your own beast forward for a moment, he will contrive to wheel and draw back: the responsibility of finding the way is evidently assumed very unwillingly. After some time, however, it becomes understood that one of the beasts has reluctantly consented to take the lead, and he accordingly advances for that purpose. For a minute or two he marches with great indecision, taking first one line, and then another, but soon, by the aid of some mysterious sense, he discovers the true direction, and thenceforward keeps to it steadily, going on from morning till night. When once the leadership is established, you cannot by any persuasion, and scarcely even by blows, induce a junior camel to walk one single step in advance of the chosen guide.

Needlework.

FEMALES.

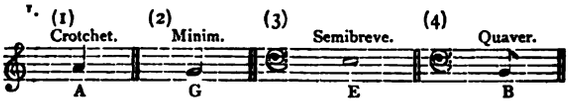
One hour will be allowed for this exercise, in the afternoon.

Music.

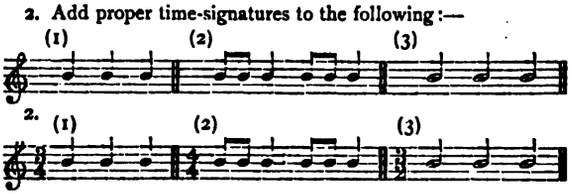
A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

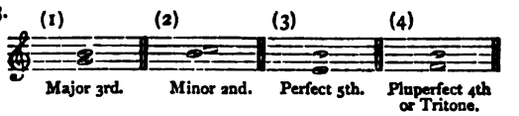
1. Write above each of the following notes its value-name (semibreve, &c.), and below each its pitch-name (C, B, or Do, Si, &c.):—



2. Add proper time-signatures to the following:—



3. Write below each of the following intervals its name (major fourth, &c.):—



TONIC SOL-FA NOTATION.

1. Re-write the following an octave higher, doubling the value of every note:—

| m :s | f :r | l :s | s :— ‖

1. | m' :— | s' :— | f' :— | r' :— | l' :— | s' :— | s' :— | — :— ‖

2. What do "Key A," "Key B," mean at the beginning of a tune?

2. That the sounds of A and B are to be found, and these sounds are to be tonics, or key-notes, of the music to which they are respectively placed.

3. Write the names of the following intervals:—(1) *soh* to *te*; (2) *te* to *doh'*; (3) *me* to *te*; (4) *fah* to *te*.

3. (1) Major 3rd; (2) Minor 2nd; (3) Perfect or Major 5th; (4) Pluperfect 4th or Tritone.

SECOND YEAR.

Pupil Teachers at end of Second Year.

FIRST PAPER.

Three hours and a half allowed for this Paper.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

1. From the greater of two given straight lines to cut off a part equal to the less. Point out the *data* and the *quæsita* in this proposition.

Euclid, Book I., Prop. 3.

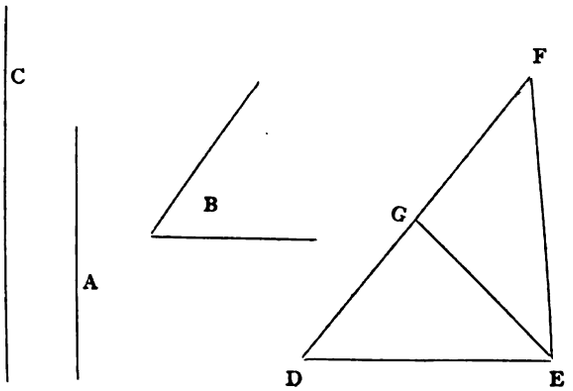
Data:—"Let A B and C be the two given straight lines, of which A B is the greater."

Quæsita:—"It is required to cut off from A B a part equal to C."

2. If two triangles have two angles of the one equal to two angles of the other, each to each, and one side equal to one side, viz., either the sides adjacent to the equal angles in each, or the sides opposite to them, then shall the other sides be equal each to each, and also the third angle of the one equal to the third angle of the other.

Euclid, Book I., Prop. 26.

3. Construct a triangle whose base shall be equal to a given line, one of the angles at the base equal to a given angle, and the sum of the two other sides equal to a given line.



Let A be the given line for the base, B the given angle, and C the given line = to the sum of the other sides of the triangle.

Draw DE = A (I. 3). At the point D in the line DE, make the ∠ EDF = ∠ B (I. 23).

Make DF = C. Join EF.

At the point E in the straight line EF make ∠ FEG = ∠ EFG. Let EG meet DF in G.

∆ DGE = ∆ required.

Because ∠ GEF = ∠ GFE, GE = GF (I. 6).

But DF = C (Const.), ∴ DG, GE = C.

And DE = A, and ∠ EDG = ∠ B (Const.).

∴ GDE = ∆ required. Q. E. F.

Arithmetic.

FEMALES.

1. Simplify :—

$$(a)\ \frac{2\frac{1}{10}\text{ of }\frac{3}{5}-1\frac{1}{2}\text{ of }\frac{3}{5}}{1\frac{1}{21}\div 5\frac{5}{7}}$$

$$(b)\ \frac{1}{1+\frac{7}{13\frac{3}{4}}}$$

$$6\tfrac{3}{4}$$

$$(a)\ \frac{2\frac{1}{10}\text{ of }\frac{3}{5}-1\frac{1}{2}\text{ of }\frac{3}{5}}{1\frac{1}{21}\div 5\frac{5}{7}}$$

$$=\frac{\frac{21}{10}\times\frac{3}{5}-\frac{3}{2}\times\frac{3}{5}}{\frac{22}{21}\times\frac{7}{30}}$$

$$=\frac{\frac{63}{50}-\frac{3}{4}}{\frac{11}{15}}$$

$$=\frac{60-39}{\frac{52}{15}}$$

$$=\frac{21}{52}\times\frac{15}{11}$$

$$=\frac{315}{572}$$

$$=\underline{2\tfrac{71}{572}}.\ \text{Ans.}$$

$$(b)\ \frac{1}{1+\frac{7}{13\frac{3}{4}}}$$

$$6\tfrac{3}{4}$$

$$=\frac{1}{1+\frac{7}{\frac{55}{4}}}$$

$$=\frac{1}{1+\frac{28}{55}}$$

$$=\frac{55}{83}+\frac{28}{83}$$

$$=\underline{1}.\ \text{Ans.}$$

2. A man spends $\frac{1}{2}$ of his money, then $\frac{1}{4}$ of the remainder, and then $\frac{1}{5}$ of what was still left. He finally has £25 in hand; how much had he at first?

Spent	Left
$\frac{1}{2}$.	$\frac{1}{2}$.
,, $\frac{1}{4}$ of $\frac{1}{2}=\frac{1}{8}$	,, $\frac{1}{2}-\frac{1}{8}=\frac{3}{8}$
,, $\frac{1}{5}$ of $\frac{3}{8}=\frac{3}{40}$	,, $\frac{3}{8}-\frac{3}{40}=\frac{3}{10}$

$\therefore \frac{3}{10}=$ £25.

and $\frac{1}{10}=$ £100. Ans.

3. Find the value of $6\frac{3}{16}$ of a florin + $2\frac{1}{3}$ of half-a-crown − $\frac{1}{10}$ of five shillings − $\frac{3}{4}$ of a pound.

$6\frac{3}{16}$ of 2s. + $2\frac{1}{3}$ of 2s. 6d. − $\frac{1}{10}$ of 5s. − $\frac{3}{4}$ of 20s.

$=\frac{99}{16}\times\frac{2}{1}+\frac{7}{3}\times\frac{5}{2}-\frac{1}{2}-15.$

= 12s. $4\frac{1}{2}$d. + 6s. 6d. − 6d. − 15s.

$=\underline{3\text{s. }4\frac{1}{2}\text{d.}}$ Ans.

4. Express the following as a decimal fraction :—

$$\frac{(\frac{3}{4}-\frac{3}{7})\div(\frac{4}{5}-\frac{5}{6})}{(\frac{2}{3}-\frac{4}{7})\div(\frac{4}{5}-\frac{5}{14})}$$

$$=\left(\frac{14-9}{21}\right)\div\left(\frac{35-15}{42}\right)$$

$$=\frac{5}{21}\times\frac{42}{20}$$

$$=\frac{1}{2}$$

$$=\underline{.5}.\ \text{Ans.}$$

Grammar.

MALES AND FEMALES.

1. They err, who *count it glorious* to *subdue*
By conquest *far* and *wide*, to overrun
Large countries, and in fields great *battles win*,
Great *cities* by assault. MILTON.

Analyse the foregoing, parsing the words in italics.

2. Paraphrase the lines.

3. What Latin prefixes occur in it? Give instances of the same prefixes undergoing a modification in other words.

ANALYSIS.

Sentence.	Kind of Sent.	Connective.	Subject.	Predicate.	Object.	Extension.
(*a*) They err	P. S.		They	err		
(*b*) who count it glorious to subdue by conquest far and wide	Adj. S. to *a*	In *rel. pro.*	who	count	it glorious to subdue by conquest far and wide	
(*c*) to overrun large countries	Adj. S. to *a* (contracted)	do.	[who]	[count]	[it glorious' to overrun large countries	
(*d*) and in fields great battles win	Adj. S. to *a* (contracted)	and	[who]	count	[it glorious] to win great battles in fields	
(*e*) Great cities by assault.	Adj. S. to *a* (contracted)	In *rel. pro.*	[who]	[count]	[it glorious] to win great cities by assault.	

PARSING.

Count—reg. trans. verb, act. ind., pres., 3rd plur., agreeing with its nom. 'who.'

it—pers. pro., neut., sing., obj., gov. by 'count.'

glorious—adj. of quality, qual. 'it.'

subdue—verb, reg. trans. (used intransly.), act. inf., used as abs. noun, neut, sing., 3rd., obj., in appo. with 'it.'

far—adv. of place, qual. 'subdue.'

wide—adv. of place, qual. 'subdue.'

battles—com. noun, neut., plural, 3rd, obj. gov. by 'win.'

win—verb. reg. trans. act. inf., used as abs. noun, neut., obj., in appo. with 'it.'

cities—com. noun, neut., plur., obj., gov. by 'to win.'

(2) Those persons make a great mistake who imagine that there is any real grandeur or nobility in subjugating whole districts by force, subduing whole nations, winning great victories in the battlefield, or taking great cities by storm.

(3) *Sub* becomes *suf* in *suffice*, *suc* in *succeed*, *sur* in *surrender*. *con* becomes *co* in *co-operate*, *com* in *commit*, *col* in *collect*, *cor* in *correct*.

at becomes *ad* in *adhere*, *ac* in *accede*, *af* in *affix*, *ag* in *aggression*, *al* in *allot*, *an* in *annex*, *ap* in *appear*, *ar* in *arrest*, *at* in *attend*.

4. The termination 'age' sometimes forms abstract nouns, sometimes denotes the 'place where.' Give examples of both uses.

Abstract nouns: Marriage, homage, salvage, espionage, dotage, age, savage, voyage, bondage.

Place where: Hermit-age, vicar-age, parson-age, pass-age.

Geography.

(*Answer either Ques.* 2 *or Ques.* 3, *not both.*)

1. '*Simla is the favourite retreat of the Governor-General of India when forced to escape from the unhealthy climate of Calcutta.*'

Explain this statement, and mention any other spots in India which serve the same purpose.

1. [*For answer to this question, see answer to Ques.* 3, *Geography, Third Year Papers.*]

2. Draw a map of the coast-line from Gibraltar to the Dardanelles.

Insert the lines of latitude and longitude.

3. In which of the British possessions can cotton, tea, and sugar be grown? Describe the climate of each.

Cotton can be grown in India and Queensland, *tea* in Assam, and *sugar* in Mauritius, the West Indies, and India.

The climate of India, owing to its great extent, is varied. From its position it is naturally very hot, but the climate is tempered by the inequalities of the surface. It has three seasons, the hot, the wet, and the temperate. Monsoons blow for six months in the year from north-east, and for the other six months from the south-west. Rainy days are not very numerous, but the rainfall is heavy.

Queensland is hot, and is subject to drought, but it is healthy and free from burning winds.

Assam is a part of India, and has a delightful climate, although in the northern part, among the hills, a large amount of rain falls.

The West Indies are hot and unhealthy, and subject to frequent hurricanes.

The position of the Mauritius makes its climate damp, but it is not unhealthy. Hurricanes are very destructive and frequent.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. In a school, 150 children were examined, and the average percentage of passes was 86. If 96 per cent. passed in reading, and 84 per cent. in writing, how many *failed* in arithmetic?

Total number of passes $= \frac{150 \times 86 \times 3}{100} = 387$ passes.

Passes in reading $= \frac{150 \times 96}{100} = 144$ passes.

Passes in writing $= \frac{150 \times 84}{100} = 126$ passes.

Passes in arithmetic $= 387 - (144 + 126) = 117$ passes.

Failures in arithmetic $= 150 - 117 = \underline{33}$. Ans.

2. At what rate per cent. per annum, simple interest, will £850 10s. amount to £910 0s. 8½d. in 2 yrs. 292 days?

Total interest = £910 0s. 8½d. − £850 10s. = £59 10s. 8½d.

2 yrs. 292 days = 2¾ yrs.

Gain of £850½ in 2¾ yrs. = £59 10s. 8½d.

" 1 " 1 " $= \frac{\text{£}59\ 10\text{s.}\ 8\frac{1}{2}\text{d.}}{850\frac{1}{2} \times 2\frac{3}{4}}$

" 100 " 1 " $= \frac{\text{£}59\ 10\text{s.}\ 8\frac{1}{2}\text{d.} \times 100}{850\frac{1}{2} \times 2\frac{3}{4}}$

$= \underline{\text{£}2\frac{1}{4}}$ = rate per cent.

3. If by investing in 4 per cent. railway debentures, a man gets 5⅓ per cent. for his money, what is the price of the debentures? (Omit brokerage.)

Price paid to get 5⅓ = 100

" " $= \frac{100}{5\frac{1}{3}}$

" " $4 = \frac{100 \times 4}{5\frac{1}{3}} = \underline{75}$. Ans.

4. If 6 men in 5 days build a wall 25 yards long, 2 feet wide, and 8 feet high, in how many days will 10 men build a wall 30 yards long, 2½ feet wide, and 6 feet high?

days. days.

men 10 : 6 :: 5 : x

yards 25 : 30

feet 2 : 2½

feet 8 : 6

$\frac{5 \times 6 \times 30 \times 2\frac{1}{2} \times 6}{10 \times 25 \times 2 \times 8} = \underline{3\frac{3}{4}}$ days. Ans.

History.

MALES AND FEMALES.

1. What sort of dwellings did the Normans inhabit in this country? And why?

The Norman nobles occupied castles of great strength, erected in commanding situations, and surrounded by a moat. Round about the castles were clustered the shops and houses, built of stone, which were occupied by the persons in the employ of the barons and their vassals. The country was very unsettled, and very often quarrels took place between different barons, and sometimes between the barons and the King. The castles therefore were built for strength and safety in turbulent times. The ruins of many of them may still be seen in different parts of the country. The people who resided in the houses were enabled for protection, and also to assist in the defence, to go into the castle on the first approach of danger.

2. In the time of Henry III. what were the relations of England and Wales, and what was the condition of the March country?

The inhabitants of Wales often made incursions into England for the sake of plunder, and invasions of Wales by the nobles were made during Henry III.'s reign for the sake of reprisal. Gradually a chain of castles belonging to the English was being made across South Wales to Milford Haven the starting place for Ireland, and if one of these castles fell into the hands of the Welsh, the day was kept as a day of joy and feasting.

Llewelyn, the prince of North Wales, took the part of the barons in the wars of Henry III., and this led to the ultimate invasion and conquest of Wales in the following reign.

The March country was laid waste; castles, towns, and villages were destroyed, and the inhabitants either put to death or driven from the district, which became one vast uncultivated desert.

3. Who was the first Queen Regnant of England? Explain her connection with Spain.

Mary, daughter of Henry VIII. and Catherine of Arragon (1553-1558), was the first Queen who reigned alone over England.

She was married by proxy to Philip, Prince of Castile, the son of Charles V., Emperor of Germany, contrary to the wishes of her Parliament and people. The marriage was celebrated in England at Winchester by Bishop Gardner, July, 1554, and from that time all acts of government were issued in the names of King Philip and Queen Mary. Philip left England for the Netherlands in 1555, but returned again in 1557, but left it soon afterwards to carry on the war with France.

Teaching.

1. How would you propose to secure intelligent reading in your class?

Children cannot read intelligently that which they do not understand. The following points should be attended to therefore in order to secure intelligent reading in a class:—

(1) Teacher should know the piece to be read, and should therefore prepare it before the time for the reading lesson.

(2) Having done so, he should be ready to explain any difficult words or phrases in the lesson, and to find out by questioning whether the simpler passages are understood.

(3) He should read intelligently himself, setting a good pattern to the class, which should be followed by the children, simultaneously first, and then individually.

(4) All errors should be pointed out by the children if possible; if not, by the teacher.

(5) Care should be taken to see that due regard is paid to speed, the stops, and the inflections and intonation required. In all cases a good pattern should be set by the teacher.

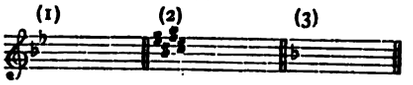
I should follow the above rules in order to secure intelligent reading in my class.

Music.

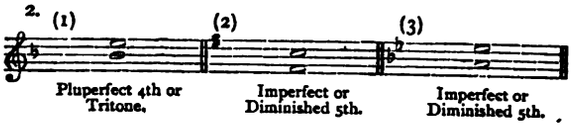
A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write the key-signatures of each of the following major keys :—(1) of B♭; (2) of E; (3) of F.

1. (1) (2) (3)

2. Write below each of the following intervals its name (major third &c.) :—

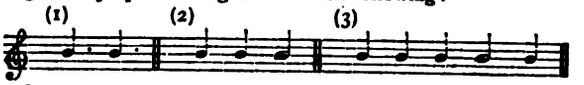
2. (1) (2) (3)

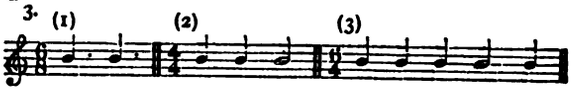


Pluperfect 4th or Tritone. Imperfect or Diminished 5th. Imperfect or Diminished 5th.

3. Add proper time-signatures to the following :—

(1) (2) (3)



3. (1) (2) (3)

TONIC SOL-FA NOTATION.

1. What is the mental effect of (1) *te*? and of (2) *fah*? and of (3) *lah*?

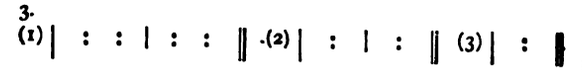
1. (1) Expectant and piercing; (2) serious and plaintive; (3) sad.

2. Write the names of the following intervals :—(1) *fah* to *te*; (2) *me* to *doh*^{1}; (3) *fah* to *doh*^{1}.

2. (1) Pluperfect 4th or Tritone; (2) Minor 6th; (3) Major or Perfect 5th.

3. Write (1) a six-pulse measure; (2) a four-pulse measure; (3) a two-pulse measure.

3.



(1) (2) (3)

THIRD YEAR.

Pupil Teachers at end of Third Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including No. 3, if you can.

1. To draw a straight line through a given point parallel to a given straight line.

Euclid, Book I., Prop. 31.

2. In any right-angled triangle the square which is described upon the side subtending the right angle is equal to the squares described upon the sides which contain the right angle.

Euclid, Book I., Prop. 47.

3. If all the sides of a polygon be produced in both ways, the angles formed by the meeting of every two alternate sides, with eight right angles, will together amount to twice as many right angles as the figure has sides.

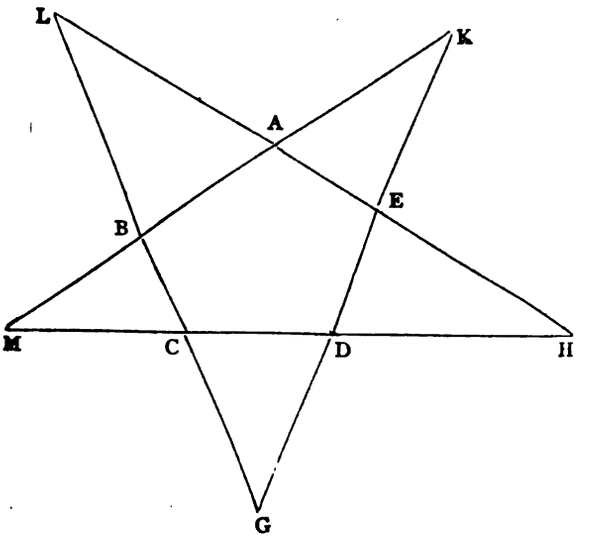
Let ABCDE be any polygon, and let all the sides be produced both ways to meet in G, H, K, L, M. Then the angles at G, H, K, L, M together with eight right ∠'s = twice as many right ∠'s as the fig. has sides.

For all the exterior ∠'s made by producing the sides in one direction = four right angles.

∴ All the exterior ∠'s made by producing the sides in both directions = eight right ∠'s. But all the exterior ∠'s together with the ∠'s at G, H, K, L, M = all the ∠'s of the triangles;

∴ The ∠'s at G, H, K, L, M together with eight right ∠'s = all the ∠'s of the triangles:

And all the ∠'s of the triangles = twice as many right ∠'s as there are triangles, *i.e.*, as the fig. has sides. (I. 32.)



∴ All the ∠'s at G, H, K, L, M together with eight right ∠'s = twice as many right ∠'s as the fig. has sides.
Wherefore, if all the sides, etc.

Q. E. D.

Algebra.

Answer two Questions.

1. Find the value of

$$\frac{18a^3-5ab^2-b^3}{3a+b}+\frac{27a^3-125b^3}{3a-5b} \text{ when } a=3,\ b=-4.$$

$$\frac{18a^3-5ab^2-b^3}{3a+b}+\frac{27a^3-125b^3}{3a-5b}$$
$$=\frac{486-240+64}{9-4}+\frac{729+8000}{9+20}$$
$$=\frac{310}{5}+\frac{8729}{29}$$
$$=62+301$$
$$=\underline{363}. \text{ Ans.}$$

2. Find the G.C.M. of $6x^5-4x^4-11x^3-3x^2-3x-1$ and $4x^4+2x^3-18x^2+3x-5$.

$4x^4+2x^3-18x^2+3x-5)$
$6x^5-4x^4-11x^3-3x^2-3x-1$ $\quad$ 4
$24x^5-16x^4-44x^3-12x^2-12x-4$ $\quad (6x-7$
$24x^5+12x^4-108x^3+18x^2-30x$
$-28x^4+64x^3-30x^2+18x-4$
$-28x^4-14x^3+126x^2+21x+35$
$39)\ 78x^3-156x^2+39x-39$
$2x^3-4x^2+x-1$
$2x^3-4x^2+x-1)4x^4+2x^3-18x^2+3x-5(2x+5$
$4x^4-8x^3+2x^2-2x$
$10x^3-20x^2+5x-5$
$10x^3-20x^2+5x-5$

G.C.M. $=\underline{2x^3-4x^2+x-1}$. Ans.

3. A woman took eggs to market, and sold, first, six less than half; then six less than one-third of the remainder; finally six less than one-fourth of those remaining. On counting her eggs she found she had sold half. How many had she at first?

Let x = No. she had at first

then $\frac{x}{2}-6$ = No. sold first.

and $\frac{x}{2}+6$ = No. after first sale.

then $\frac{1}{3}\left(\frac{x}{2}+6\right)-6$ = Second sale.

and $\frac{2}{3}\left(\frac{x}{2}+6\right)+6$ = No. after second sale.

then $\frac{1}{3}\left(\frac{x}{3}+10\right)-6$ = Third sale.

and $\frac{2}{3}\left(\frac{x}{3}+10\right)+6$ = No. after third sale.

By question $\frac{x+30}{4}+6=\frac{x}{2}$

$$x+30+24=2x.$$

$$x=\underline{54}. \text{ Ans.}$$

Mensuration.

The area of a triangle is 19 a. 3 r. 8 p., and the perpendicular is 18 chains; find the base in chains.

$$\text{Base}=\frac{\text{Area}}{\text{Per.}\times 2}$$

$$\therefore \frac{9 \text{ a. } 3 \text{ r. } 8 \text{ p.}}{18 \text{ ch.}\times 2}$$

$$=\frac{2}{1}\frac{2}{4}\frac{2}{4}$$

$$=\underline{22 \text{ chains.}} \text{ Ans.}$$

Arithmetic.

FEMALES.

1. Divide ·6024 by ·0012 and ·000405 by 13·5.

$$\underline{502.} \text{ Ans.} \qquad \underline{405}$$

2. Find the value of ·34$\frac{5}{9}$ of 9s. 2d. + $\frac{2}{3}$ of ·075 of £10 + ·05 of 1·125 of £1 13s. 4d., and express the result as a decimal fraction of £5.

·34$\frac{5}{9}$ of 9s. 2d. + $\frac{2}{3}$ of ·075 of £10 + ·05 of 1·125 of £1 13s. 4d.

$$=\frac{3}{8}\frac{1}{8}\times\frac{1}{1}\frac{1}{2}+\frac{2}{3}\times\frac{1}{1}\frac{8}{0}\frac{0}{0}\times\frac{2}{1}\frac{0}{2}+\frac{1}{1}\frac{8}{0}\frac{0}{0}\times\frac{2}{3}\times\frac{4}{1}\frac{0}{2}$$

$$=38\text{d.}+12\text{s. } 6\text{d.}+22\tfrac{1}{2}\text{d.}$$

$$=17\text{s. } 6\tfrac{1}{2}\text{d.}$$

and $\frac{17\text{s. } 6\frac{1}{2}\text{d.}}{£5}=\underline{\cdot 175416}$. Ans.

3. A rate of 2s. 9d. in the £ on the rental of a parish produces £352; what is the rateable value of the parish?

Rateable value for 2s. 9d. = £1

" " 1d. = $\frac{1}{33}$

" " £352 = $\frac{1\times 352\times 240}{33}$

$$=\underline{£2560}. \text{ Ans.}$$

4. Reduce 1·432 of five bushels to pints and the decimal of a pint.

1·432

5

bush. 7·160

4

pks. 28·640

8

qts. 229·120

2

pts. 458·240. Ans.

Grammar.

MALES AND FEMALES.

1.

Yet haply of thy race
In future days, if malice *should abound*,
Some one intent on mischief or *inspir'd*
With devilish machination *might devise*
Like instrument to plague the sons of men.

MILTON.

Analyse the above passage, parsing the words in italics.

2. Paraphrase it.

3. Point out all the Latin prefixes in it, and give their meaning.

ANALYSIS.

Sentence.	Kind of Sent.	Connective.	Subject.	Predicate.	Object.	Extension.
(*a*) Yet haply of thy race in future days, some one intent on mischief or inspired with devilish machination might devise like instrument to plague the sons of men	P.S.	Yet	some one of thy race intent on mischief or inspired with devilish machination	might devise	like instrument	haply (mood) in future days (time) to plague the sons of men (purpose).
(*b*) if malice should abound	Adv. of cond.	if	malice	hould abound		

Yet—conj. cop., joining 'some one might devise' to preceding sentence.
haply—adv. of mood, qualifying 'might devise.'
should—aux. verb to abound, indicating pot. mood past.
abound—verb, reg. intrans., inf. pres. gov. by 'should.'
should abound—verb, reg. intrans. act., pot. with conditional form, 3rd sing., agreeing with its nom. 'malice.'
some—indef. num. adj. qual. 'one.'
one—indef. pers. pro., com., sing., 3rd, nom., to 'might desire.'
intent—adj. of quality, qualifying 'one.'
inspired—adj. of quality, participial, qual. 'one.'
might—aux. verb to 'desire,' indicating pot. past.
devise—verb, reg. trans., inf. pres. gov. by 'might.'
might devise—verb, reg. trans., act. pot. past, 3rd, sing. agreeing with its nom. 'one.'
like—adj. of quality, qual. 'instrument.'

4. Form derivatives and compounds from the word 'hap.'

Happy, haply, happen, hapless, hap-hazard, mishap, happiness, happily, haplessly.

Geography.

Answer Q. 1, and either Q. 2, or Q. 3.

1. Give notes of a lesson on 'Central Africa: its Climate, Productions, Inhabitants, and Explorers.'

Illustrate by a map. Insert the lines of latitude and longitude, and the tropics.

Its position, etc.—Two divisions, N. and S. Central. Former includes Sahara and Soudan. Latter, newly-explored country, 10° N. to 25° S. of equator, 2000 miles in length, 1200 to 1500 in breadth. Watered by Congo and Zambesi in S., lakes and Nile in N.

Climate.—Dependent principally upon its position. The interior, once thought like Sahara, found to consist of immense plateaus, which are excessively hot, but in some months tempered by the heavy rains.

As we near the S. the climate is delightful. Near some of the lakes the land is swampy, and there malaria prevails, as is the case as the coast is approached.

Productions.—Almost all kinds of wild animals: elephant, hippopotamus, rhinoceros, lion, zebra, quagga, and giraffe; deer, gorilla, chimpanzee, and monkeys; leopard, panther, camel. Ostrich, parrots, and birds of beautiful plumage; ants and locusts. Vegetable: palm, pomegranate, cocoa-nut, cassava, ginger, ground-nut, tamarind, baobab, plants yielding myrrh, cassia, and oils; near the south cacti and heaths.

Inhabitants.—Various classes of negroes, of one distinct and indigenous race occupy the district from the Soudan southward. Arabs occupy the northern part and rule the negroes. In the south the inhabitants are Kaffirs. Slavery common, carried on with great cruelty. Negroes shipped to Arabia, etc. Tribes quarrel and make slaves of each other.

Explorers.—Livingstone from the S.; sketch travels from Cape northwards. Stanley followed, crossed the Dark Continent, sailed down Congo. Burton, Speke, Grant, and Baker worked from N., explored Nile and lakes.

2. What are monsoons and typhoons? In what parts of Asia are they chiefly felt? Describe their effects.

Monsoons are the trade winds modified by the heat of the continents of Africa and Asia, but differing from them in being periodical and not perennial. They blow in the Indian Ocean from N.E. and S.W. alternately for six months in the year. The S.W. monsoon carries with it moisture from the Indian Ocean, and causes heavy rains in the Ghauts, and great quantities of snow in the Himalayas.

Typhoons are cyclonic winds, common in the torrid zone, especially near its outer edge, and very frequent along the Chinese coasts. The wind has a circular motion, the whole storm proceeding in a line. The barometer falls suddenly, wind blows with hurricane violence, sweeping everything before it; the sea rises, rushes over the land, and often does great damage. Typhoons are accompanied with shocks of earthquake and heavy thunderstorms, the lightning being very vivid and frequent.

3. '*Simla is the favourite retreat of the Governor-General of India when forced to escape from the unhealthy climate of Calcutta.*'

Explain this statement, and mention any other spots in India which serve the same purpose.

The climate of India is unsuited to Europeans. The heat on the low plains, especially those near the mouth of the Ganges, in the neighbourhood of Calcutta, is almost unbearable. The district is full of swamps and jungle, and these are the unhealthy parts. On the high lands the air is purer and cooler, and the climate more like that of England in the summer months. To towns situated on the hills, Europeans therefore resort in great numbers during the hot season. Of these towns, *Simla*, near the left bank of the Sutlej, among the Himalayas, is most frequented by the residents of Calcutta and the Ganges valley. Here the Governor-General has a residence. Other towns in other parts of the country are, *Darjeeling*, south of Sikkim, *Mount Aboo*, in the Aravulli range and *Mahabulkshwar;* also several places in the *Neilgherries*.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. If a farmer's rent be 200 guineas, and his landlord accepts £183 15s. instead, what percentage does the landlord remit?

200 guineas = £210

Total remission = £210 − £183 15s. = £26 5s.

Remission on £210 = 26½

" " 1 = $\frac{26\frac{1}{2}}{210}$

" " £100 = $\frac{26\frac{1}{2} \times 100}{210} = 12\frac{1}{2}$. Ans.

2. How much money must I invest in 3½ per cent. railway stock at 87⅞ to obtain an income therefrom of £112, the usual brokerage being charged?

Cost of stock = $87\frac{7}{8} + \frac{1}{8} = 87\frac{1}{2}$

Money invested to produce 3½ = 87½

" " " 1 = $\frac{87\frac{1}{2}}{3\frac{1}{2}}$

" " " 112 = $\frac{87\frac{1}{2} \times 112}{3\frac{1}{2}}$

= £2800. Ans.

3. Find the square root of 159014·732 to four decimal places, and show that $\sqrt{2\frac{7}{144}} = 1{\cdot}58\frac{1}{3}$.

```
159014·7320000(398·7665+   Ans.
  9
69)690
   621
788)6914
    6304
7967)61073
     55769
79746)530420
      478476
797526)5194400
       4785156
7975325)40924400
        39876625
        1047775
```

$\sqrt{2\frac{7}{144}} = \sqrt{\frac{295}{144}} = \frac{17}{12} = 1{\cdot}58\frac{1}{3}$

4. If the present value of a bill of £744 6s., due 9 months hence, is £720, find the rate of interest per annum.

Interest of £720 for 9 months = $24\frac{3}{10}$

" " 1 " 1 " = $\frac{24\frac{3}{10}}{720 \times 9}$

" " 100 " 12 " = $\frac{24\frac{3}{10} \times 12 \times 100}{720 \times 9}$

= 4⅓. Ans.

History.

MALES AND FEMALES.

1. Write an account of the Fire of London, and show what improvements followed upon it. Tell the name and date of the famous architect of that period.

The Great Fire of London broke out in a baker's shop in the east of the city on Sunday, September 2, 1666. It raged for three days, and as a strong wind was blowing, its course was very rapid and extensive. The whole city was cleared from the place now occupied by the Monument to the Temple in Fleet Street, and from the river to Holborn in the north. Four hundred streets, 13,000 houses, many churches, including Old St. Paul's were destroyed. The fire was only stayed by the great gaps which had been made by blowing down the houses on every side. The remnants of the plague were destroyed, and when rebuilt, the streets were wider, the houses of brick or stone instead of wood, and St. Paul's, the largest Protestant church of the world, besides the Monument, were built by Sir Christopher Wren, (1632-1723) the most famous architect of the period.

2. What princes are known as the Old Pretender and the Young Pretender? Describe any efforts to secure higher titles for them.

James, the son of James II., was known as the Old Pretender, and his son, Charles Edward Stuart, as the Young Pretender. Attempts were made in 1715 to put James, and in 1745 to put Charles on the English throne. The Earl of Mar raised a rebellion in Scotland, and the Earl of Derwentwater in England. The English were defeated at Preston, and the Scotch at Sheriffmuir, near Stirling. James landed at Peterhead, but soon fled the country. Derwentwater and others were beheaded on Tower Hill. In 1745, Charles Edward landed in Inverness-shire with seven followers. He marched south, occupied Perth and Edinburgh, gained the battle of Prestonpans, and advanced south as far as Derby. Meeting, however, with little support, he retired, checking Cumberland at Clifton Moor, but finally being defeated at Culloden, near Inverness. After many dangers and hardships he escaped to France, dying in 1788.

3. Sketch the rise of British power in India, and show how our position in Asia gives importance to Egypt.

The first settlement by the English in India was at Surat, in 1612. Afterwards Bombay, Madras, and Calcutta were added. Trade flourished till 1745, when quarrels arose with the French, who also had settlements, each nation supporting rival native princes. The battle of Plassy, after the affair of the Black Hole of Calcutta, destroyed Surajah's power, and gave Britain possession of Bengal, Bahar, and Orissa. From that time (1757) there has been a gradual annexation of provinces, either after conquest or cession, till at the present time Britain owns more than three-fourths of the country. These annexations took place under Warren Hastings, Marquis of Wellesley, Marquis of Hastings, Earl Amherst, Lord Ellenboro', Lord Hardinge,

and Lord Dalhousie, successive Governor-Generals of the country. It is the most important possession of England. The shortest way to it is through the Suez Canal, and the holder of Egypt might prove very troublesome as an enemy of England. It is this fact which renders the question of the government of Egypt of importance to England.

Teaching.

Write out the notes of a lesson on 'CASE.'

Introduce the lesson by writing on blackboard three sentences, such as the following :—

(1) The boy broke the window.
(2) The dog bit the boy.
(3) I found the boy's book.

Elicit, by questioning, the fact that the word 'boy' is used in different ways in the three sentences : (1) As acting, (2) As being acted upon, (3) As owning. The word does not stand in same relationship to other words of sentences. Word to denote the relationship is *Case.*

Definition. Case is the form of the word to show the relationship a noun bears to other words in the sentence. (Write on blackboard, and have committed to memory.)

Kinds of Cases. Three, corresponding to uses of word in examples given. (1) When acting, or spoken about, *Nominative.* (2) When acted upon, or following a preposition, *Objective.* (3) When denoting possession, *Possessive.* Show appropriateness of names of cases.

How to distinguish Case of Nouns. By their use, as stated in kinds of cases. Other aids : Nominative answers to question *who?* or *what? before the verb ;* Objective to *whom?* or *what? after the verb ;* Possessive to *whose?* with the noun. Show that forms of Nominative and Objective are alike, but Possessive singular is known by (') before the 's,' and plural after the 's.'

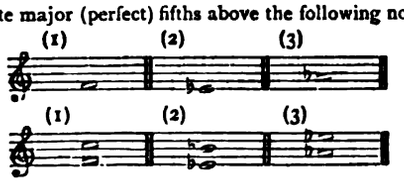
Application. Give numerous examples on blackboard, and from reading book. Question for recapitulation.

Music.

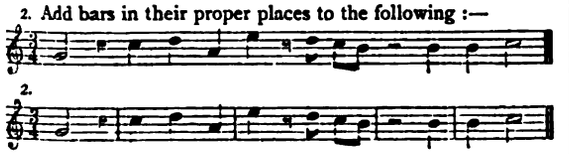
A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both.* The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write major (perfect) fifths above the following notes :—



2. Add bars in their proper places to the following :—



3. State (briefly) the meanings of the following terms :—(1) *Dolce* ; (2) *Diminuendo* ; (3) *Accelerando.*

4. (1) That the music above which it is placed must be sung sweetly ; (2) that the music must become gradually softer ; (3) that the speed of the music is to be increased.

TONIC SOL-FA NOTATION.

1. Write major (perfect) fifths above the following :—(1) *fah* ; (2) *ray* ; (3) *te.*

1. (1) d^1 ; (2) l ; (3) fe^1.

2. Re-write the following, doubling the value of every note and rest. Use four-pulse measure.

$$|d^1 \quad :s.f \;|m.r : \quad |m.r :d \;\|$$

2.

$$|d^1 :- \;|s \;:-.f \;|m \;:r \;| \;: \;|m \;:r \;|d \;:- \;\|$$

3. What do the following terms mean :—(1) *Dolce* ; (2) *Diminuendo* ; (3) *Accelerando?*

4. (1) That the music is to be sung sweetly ; (2) that the music must become gradually softer ; (3) that the speed is to be gradually increased.

FOURTH YEAR.

Pupil Teachers at end of Fourth Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including No. 3, if you can do so.

1. If a straight line be divided into any two parts, the squares on the whole line, and on one of the parts, are equal to twice the rectangle contained by the whole and that part, together with the square on the other part. What is the corresponding algebraical formula?

Euclid, Bk. II., Prop. 7.

Let AB contain x units, and AC, CB contain y and z units respectively :—

Then $x=y+z$
Squaring both sides
$x^2=y^2+2yz+z^2$
Add z^2 to both sides ;
$\therefore x^2+z^2=y^2+2yz+2z^2$
But $2yz+2z^2=2(y+z)z$
$=2xz$
$\therefore \underline{x^2+z^2=y^2+2xz.}$

2. In every triangle, the square on the side subtending either of the acute angles, is less than the squares on the sides containing that angle, by twice the rectangle contained by either of these sides, and the straight line intercepted between the acute angle and the perpendicular let fall upon it from the opposite angle.

Euclid, Bk. II., Prop. 13.

3. If a and b represent any integers, show that lines whose lengths are proportional to a^2+b^2, $2ab$, and a^2-b^2, could form a right-angled triangle.

The sq. on one side of right-angled triangle = sum of sqs. on other two sides ; (I. 47)

$\therefore$ if a^2+b^2, $2ab$, and a^2-b^2 represent the sides of a triangle if sum of squares of any two = square of the other, the triangle would be right-angled.

(1) $(a^2+b^2)^2=a^4+2a^2b^2+b^4$
(2) $(2ab)^2 \quad = \quad 4a^2b^2$
(3) $(a^2-b^2)^2=a^4-2a^2b^2+b^4$

Add (2) and (3) and the result is $\underline{a^4+2a^2b^2+b^4}$, or the square of (1).

The sides would therefore form a right-angled triangle.

Algebra.

Answer two Questions.

1. Multiply :—

$\frac{65a^4b^3c^2}{68x^3y^4z^3}$ by $\frac{85x^4y^3z^3}{91a^3b^4c^2}$ and $\frac{a^2-x^2}{x+2a}$ by $\frac{2ax+x^2}{a(x-a)^2}$

$$\frac{65a^4b^3c^2}{68x^3y^4z^3} \times \frac{85x^4y^3z^3}{91a^3b^4c^2}$$

$$=\frac{(13a^3b^3c^2)5a}{(17x^3y^3z^3)4y} \times \frac{(17x^3y^3z^3)5x}{(13a^3b^3c^2)7b}$$

$$=\underline{\frac{25ax}{28by.}} \quad \text{Ans.}$$

$$\frac{a^2-x^2}{x+2a} \times \frac{2ax+x^2}{a(x-a)^2}$$

$$=\frac{(a+x)(a-x)}{x+2a} \times \frac{x(2a+x)}{a(x-a)(x-a)}$$

$$=\underline{\frac{x(a+x)}{a(x-a)}} \quad \text{Ans.}$$

2 Solve the equations :—

$$\left.\begin{array}{l}(1)\ 3x+5y=8xy\\ 9x-10y=xy\end{array}\right\}$$

$$(2)\ 8x+1+\frac{7}{x}=\frac{21+65x}{7}-2.$$

$$(1)\ 3x+5y=8xy\quad(\text{I.})$$
$$9x-10y=xy\quad(\text{II.})$$

Mult. (1) by 2

$$6x+10y=16xy$$
$$\underline{9x-10y=xy}$$
$$15x=17xy$$
$$15=17y$$
$$\underline{y=\tfrac{15}{17}}$$

Substituting value of y in (II.)

$$9x-\tfrac{150}{17}=\tfrac{15}{17}x$$
$$9x-\tfrac{15}{17}x=\tfrac{150}{17}$$
$$153x-15x=150$$
$$138x=150$$
$$\underline{x=\tfrac{25}{23}}.\quad\text{Ans.}$$

$$(2)\ 8x+1+\frac{7}{x}=\frac{21+65x}{7}-2$$
$$56x^2+7x+49=21x+65x^2-14x$$
$$-9x^2=-49$$
$$x^2=\tfrac{49}{9}$$
$$\underline{x=\tfrac{7}{3}=2\tfrac{1}{3}}.\quad\text{Ans.}$$

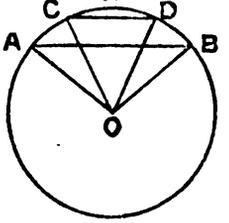
3. A father and his son can dig a garden in $3\frac{3}{7}$ days; were they to work singly, the son would take 3 days more than the father. What time would each dig it, working alone?

Let x = No. of days the father would take
then $x+3$ = " " son " "

$$\text{and}\ \frac{1}{x}+\frac{1}{x+3}=\tfrac{7}{18}$$
$$18x+54+18x=7x^2+21x$$
$$7x^2-21x=54$$
$$x^2-\tfrac{21}{7}x=\tfrac{54}{7}$$
$$x^2-\tfrac{21}{7}x+(\tfrac{21}{14})^2=\tfrac{54}{7}+(\tfrac{21}{14})^2$$
$$x-\tfrac{21}{14}=\tfrac{33}{14}$$
$$x=\underline{6}\ \text{days.}\quad\text{Father's time.}$$
$$6+3=\underline{9}\ \text{days.}\quad\text{Son's "}$$

Mensuration.

The radius of a circle is 12 feet; two parallel chords are drawn on the same side of the centre, one subtending an angle of 60° at the centre, and the other an angle of 90°; find the area of the zone between the chords.



Area of circle $=12^2\times\frac{22}{7}=452\frac{4}{7}$
Do. of sector CHDO $=\frac{1}{6}$ of $452\frac{4}{7}=75\frac{3}{7}$
Since $\angle$ COD is 60° and CO = OD the triangle COD is equilateral, and
Area of $\triangle$ COD $=12^2\times\cdot433+=62\cdot353+$
$\therefore$ Area of seg. CHD $=75\frac{3}{7}-62\cdot353=13\cdot074+$
Since AOB is a right $\angle$, $\therefore$ sector AOHB $=\frac{1}{4}$ circle.

Again :—$\therefore$ Area of sector AOBH $=452\frac{4}{7}\div4=113\frac{1}{7}$,
And area of triangle AOB $=12\times12\div2=72$,
For AOB is a right $\angle$, and its sides are equal.
$\therefore$ Area of seg. ABH $=113\frac{1}{7}-72=41\frac{1}{7}$,
And area of zone = seg. ABH − seg. CDH.
$\therefore$ Area of zone ABDC $=41\frac{1}{7}-13\cdot074+$
$=\underline{28\cdot068+\text{sq. feet.}}$ Ans.

Arithmetic.

FEMALES.

1. What time must elapse between the time of placing £28 in the savings bank, and of taking out £43 10s. 0d., supposing interest is at 3 per cent.?

Total int. = £43 10s. − £28 = £15 10s.

$$\text{Int. for 1 year}=\frac{28\times3}{100}=\tfrac{84}{100}£$$
$$\therefore\ \text{No. years.}=£15\tfrac{1}{2}\div\tfrac{84}{100}$$
$$=\tfrac{31}{2}\times\tfrac{100}{84}$$
$$=\underline{18\tfrac{11}{21}\ \text{years.}}\quad\text{Ans.}$$

2. What amount of stock must be sold out of the 3 per cents. at $87\frac{1}{2}$ to pay the present worth of £1645 17s. 6d. due 10 months hence at $3\frac{3}{4}$ per cent.?

Int. on £100 for 10 mos. at $3\frac{3}{4}$ p. c. $=\frac{10}{12}\times\frac{15}{4}=\frac{25}{8}£$
$\therefore\ 100\frac{25}{8}:1645\frac{7}{8}::100:\text{p. w.}$
$=\frac{825}{8}\times\frac{13161}{8}\times\frac{100}{825}$
$=\underline{£1596.}$

For £100 stock £$87\frac{1}{2}$ is received.
$\therefore\ 87\frac{1}{2}:1596::100:$ stock to be sold out.
$=\underline{£1824.}$ Ans.

3. The population of Huddersfield increased 101·43 per cent. between 1861 and 1871; in 1871 it was 70,253; find what it was in 1861.

100 in 1861 became 201·43 by 1871.
$\therefore$ Population in 1861
$=201\cdot43:100::70{,}253:x$
$=\underline{34{,}877.}$ Ans.

4. If 99 men can be fed for 70 days for £430, how much will it cost to feed an army of 770,000 men for 18 months of 30 days each?

$$\text{Cost of 99 men for 70 days}=£430$$
$$\text{" 1 man " 1 "}=\frac{430}{99\times70}$$
$$\text{" 770,000 " 540 "}=\frac{430\times770{,}000\times540}{99\times70}$$
$$=\underline{£25{,}800{,}000.}\quad\text{Ans.}$$

Grammar.

MALES AND FEMALES.

1. 'Suppose He should relent,
And publish grace to all, on promise made
Of new subjection; with what eyes could we
Stand in His presence humble, and receive
Strict laws imposed, to celebrate His throne
With warbled hymns, and to His Godhead sing
Forced hallelujahs.'

Analyse the foregoing down to word 'humble;' and parse the words in italics.

ANALYSIS.

Sentence.	Kind of Sentence.	Connective.	Subject.	Predicate.	Object.	Extension.
(a) Suppose	Adv. (condn.) to *d*		[you]	suppose		
(b) He should relent	Noun sent. to *a*		he	should relent		
(c) and publish grace to all on promise made of new subjection	Adv. (condn.) to *a*	and	[he]	should publish	grace to all	on promise made of new subjection (*reason*)
(d) with what eyes could we stand in His presence humble	Princ. sent.		we humble	could stand		with what eyes (*manner*) in His presence (*place*)

PARSING.

suppose—verb, reg. trans., act., cond., pres., 2nd sing., agreeing with 'you.'

relent—verb, reg. intrans., inf. pres., gov. by 'should,' and forming with 'should' past pot., 3rd sing., agreeing with 'he.'

publish—verb, reg. trans., act., inf. pres., gov. by 'should,' and forming with it the past pot., 3rd sing. of 'to publish,' agreeing with 'he.'

all—indef. numl. adj., qual. 'people,' und.
made—past part. of 'to make,' used as adj. qual. 'promise.'
what—interrog. pro., used as adj., qual. 'eyes.'
could—aux. verb, to 'stand,' irreg. intrans.
humble—adj. of quality, qual. 'we.'
receive—verb, reg. trans., act., inf. pres., gov. by 'could,' and forming with *could* the past pot., 1st plural of 'to receive,' agreeing with 'we.'
imposed—past part. of 'to impose,' used as adj., qual. laws.
warbled—past part. of 'to warble,' used as adj., qual. 'hymns.'
sing—verb, irreg. trans., act. inf., pres., gov. by 'laws.'
forced—adj. of quality, qual. 'hallelujahs.'

2. 'The cradel at hire beddes feet was sette,
To rocken.'

To what period of English does this passage belong? Point out in it *inflexions* which have become obsolete.

Late Middle English, A.D. 1350—1450.

e in *hire*, *es* in *beddes*,
te in *sette*, and
en in *rocken*.

3. Mention the chief works of Sir Walter Scott.

Poems: Lady of the Lake, Lay of the Last Minstrel, Lord of the Isles, Marmion, Rokeby, Vision of Don Roderick, Bridal of Triermain, Ballads and Songs.

Novels: Waverley, Ivanhoe, The Abbot, Monastery, Fair Maid of Perth, Kenilworth, Peveril of the Peak, Anne of Geierstein, Fortunes of Nigel, Quentin Durward, Count Robert of Paris, Woodstock, The Talisman, St. Ronan's Well, Antiquary, Bride of Lammermoor, Legend of Montrose, Black Dwarf, Old Mortality, Guy Mannering, Rob Roy, Heart of Midlothian, Red Gauntlet, Pirate, Surgeon's Daughter, Chronicles of the Canongate.

History: Tales of a Grandfather.

Geography.

(*Answer two questions.*)

(*Answer Questions* 1 *and* 2; *and No.* 3 *if you have time.*)

1. Give notes of a lesson on an eclipse of the sun, explaining

(1) Its appearance.
(2) Its cause.
(3) Why it is not always visible.
Illustrate by diagrams.

Relation of Earth and Sun and Moon.—Sun, source of light and heat; earth, a dark body; moon also dark, but reflects to earth light received from sun. Moon revolves round the earth, and earth round the sun.

Cause of an Eclipse of Sun.—Plane of moon's orbit is not coincident with plane of earth's orbit; consequently, moon does not, as it revolves round the earth, come always in a direct line between sun and earth. Were it so there would be an eclipse every day. When the earth, moon, and sun are in a direct line, the moon being between earth and sun, then there is an eclipse, body of moon obstructing rays of light from sun, and so shape of moon being seen on sun. Draw diagrams on blackboard.

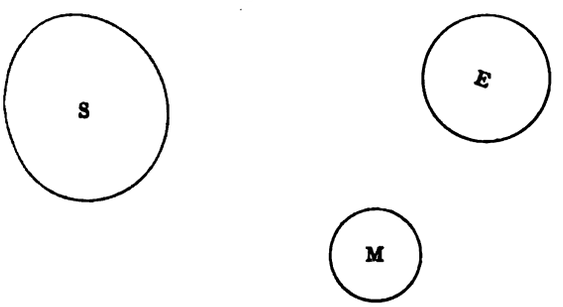


Fig. 1. Showing position of Sun, Moon, and Earth when there is no eclipse.

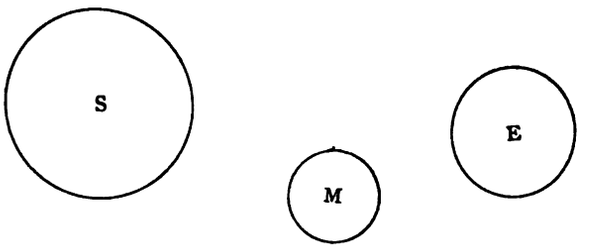


Fig. 2. Showing position when there is a partial eclipse.

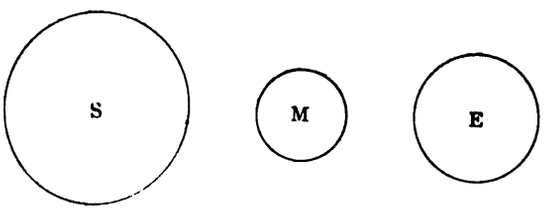


Fig. 3. Showing position when there is a total eclipse.

Why Eclipse not always visible.—When eclipse takes place during our day, and we are within the shadow of the moon cast on the earth, we see the eclipse, unless clouds interpose; but moon sometimes comes between earth and sun when it is our night and the moon is on opposite side of earth, then the eclipse is not visible to us.

2. Draw a map of the coast-line from Davis' Straits to Behring's Straits; marking also the islands lying near the coast.

Insert the lines of latitude and longitude, and say how far the coast extends to the north of the Arctic Circle.

3. Compare the mountain chains and peaks in the different continents; showing the differences in their position, directions, heights, and general character.

The general direction of the mountain chains in the Old World is from east to west, except in Africa, where there are none of great length, while the axis of the American chain is from N. to S. In the Old World also the mountains are mostly inland; in the New World they are near the coast. The average height of the mountain chains is greatest in Asia, next in America, next in Africa, and the lowest in Europe. The mountains of the New World stretch a distance of 9000 miles through the whole continent; they are precipitous on the W., and have a long slope towards the east, their highest average height is near the equator, where nearly all the mountains are volcanic, among them being Aconcagua (24,000), Sorata, Cotopaxi, Pichincha, and Chimborazo. As the range nears the North Pole it decreases greatly in height, the chief peaks being Mt. Hooker, Mt. St. Elias, and Mt. Brown.

In Asia the vast mountain chains occupy the interior of the country forming the boundaries of a very large table-land. The Himalayah range, to the S. of this table-land, has the highest peaks in the world, Kunchinjunga (28,000) and Everest (29,000) being the highest. The range is continued in a westerly direction through the continent, under the names of Hindoo-koosh, Elburz, Caucasus, Armenian Mts., and Taurus.

In Europe the great chain stretches through the centre, under the name of the Alps. The range is not so clearly defined as that of America, having many offshoots. The highest peaks are Mt. Blanc (15,000) and Mt. Rosa.

The high lands in Africa are near the coast, and are distinguished for breadth rather than height, not many reaching the snow-line. The Atlas Mts. are in the north, Kong in west, and Abyssinian in east.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. If a grocer buys cheese at £4 per cwt., and sells it at 9½d. per lb., what per cent. will he gain?

Selling price per cwt. $= 9\frac{1}{2}\text{d.} \times 112 = 1064\text{d.} = 88\frac{2}{3}$.

$$\text{Gain} = 88\tfrac{2}{3} - 80 = 8\tfrac{2}{3}$$

$$\text{Gain on } 80 = 8\tfrac{2}{3}$$

$$\text{,, } \quad 1 = \frac{8\frac{2}{3}}{80}$$

$$\text{,, } \quad 100 = \frac{8\frac{2}{3} \times 100}{80} = \underline{10\tfrac{5}{6}}. \text{ Ans.}$$

2. A man lends £1000 in four sums; if he gets 3 per cent. for £200, 3½ per cent. for £400, and five per cent. for £250, what per cent. must he get for the remainder, if his average interest is £3 17s. per cent.?

	£	s.
£1000 at £3 17s. per cent. =	38	10
£200 at £3 ,, =	6	0
£400 ,, £3½ ,, =	14	0
£250 ,, £5 ,, =	12	10
£150 =	6	0

$$\therefore \text{ rate per cent.} = \frac{6 \times 100}{150} = \underline{4}. \text{ Ans.}$$

3. A man sells out his stock in the 3½ per cents. at 97⅝, and reinvests the money in 4¾ per cent. debentures at 124⅞, and increases his income by £6 3s.; find the amount of his stock in the 3½ per cents., the usual brokerage being charged on each transaction.

Every cent. of stock is sold for $97\frac{1}{8} - \frac{1}{8} = 97$.

This invested in $4\frac{3}{4}$ stock at $124\frac{7}{8} + \frac{1}{8}$ brokerage will yield

$$\frac{97 \times 4\frac{3}{4}}{125} = £3{\cdot}705 \text{ int.}$$

Gain in income on every cent. of stock $= 3{\cdot}705 - 3\frac{1}{2} = {\cdot}205$

No. of cents. to gain ·205 = 1

$$\text{,, } \quad \text{,, } \quad 6{\cdot}15 = \frac{6{\cdot}15}{{\cdot}205} = 30$$

Amount of stock $= 30 \times 100 = \underline{£3000}$. Ans.

4. A takes 5 steps in three seconds, and B 7 steps in four seconds, but 9 of A's steps are equal to 10 of B's; compare their rates of walking.

A takes 5 steps in three secs., while B takes 7 steps in 4 secs.

$\therefore$,, $\frac{1}{5}$ steps while B takes $\frac{7}{4}$ steps

But A's step $= \frac{10}{9}$ of B's step

$\therefore$ rate of walking = A : B as $\frac{5}{3} \times \frac{10}{9} : \frac{7}{4}$

$$= \tfrac{50}{27} : \tfrac{7}{4}$$

$$= \underline{200 : 189}. \text{ Ans.}$$

History.

MALES AND FEMALES.

1. A modern Englishman whose ancestors never left these shores may count among his forefathers Italians, Scandinavians, Irishmen, Germans, Danes, Britons, French, and Netherlanders; explain this, and give the century when men of each nationality would be likely to enter the English family.

The oldest known inhabitants of this country are generally called Britons. In the first century the land was invaded by Italians under the name of Romans. Then the Picts and Scots, who originally came from Ireland, came into the country in the fifth century. Germans, under the various names of Saxons, Jutes, and Angles, were the next to gain possession of some parts of it, in the fifth and sixth centuries. After them came the Norsemen from Scandinavia and Denmark, in the eighth, ninth, and tenth centuries. Again the country was invaded by the French, in the eleventh century, under William the Conqueror, and lastly, large numbers of Flemings or Netherlanders, came over to England to escape persecution in the sixteenth century. As some of all the above nations remained in the country, a modern Englishman's ancestors may have had among them some of all the above races.

2. Of our eight kings Henry two were strikingly bold and warlike, and two were specially gentle and unfortunate; distinguish them with their dates, and the names and nationalities of their queens.

The bold and warlike were:

(*a*) *Henry IV.* (1399—1413), who married Joanna, daughter of Charles of Navarre; and

(*b*) *Henry V.* (1413—1422), who had for his consort, Catherine, daughter of Charles VI. of France.

The two whose characters were weak, and whose reigns were unfortunate, were:

(*a*) *Henry III.* (1206—1272), who married Eleanor, daughter of Raymond, Count of Provence; and

(*b*) *Henry VI.* (1422—1461), whose consort was Margaret, daughter of Réné, Duke of Anjou.

3. "A treaty of peace has been concluded between the Emperor and the First Consul. Pitt, Grenville, and Dundas have resigned upon the Catholic Emancipation. Addington is the new Prime Minister, and Hawkesbury succeeds Grenville. But the appointments are suspended in consequence of the King's illness." (Letter of Lord Lyndhurst, dated March 2nd, 1801.) Explain "Treaty of Peace" (1801), "Catholic Emancipation," "King's illness," and tell briefly what you know of any *two* of the statesmen named.

The "Treaty of Peace" was an agreement entered into for the cessation of hostilities between the Emperor of Austria and Buonaparte, who was at that time First Consul of the French Republic.

The Roman Catholics laboured under political and religious disabilities. Pitt wished to remove these disabilities, such removal being known as Catholic Emancipation.

George III. had at this time an attack of illness which proved to be a predisposition to insanity, totally unfitting him for performing the duties of kingship. This illness became permanent in 1810.

William Pitt, the son of the Earl of Chatham, was born in 1759. He entered the House of Commons at twenty-one, was a member of the Cabinet and Chancellor of the Exchequer at twenty-three, and Prime Minister at twenty-five. He succeeded in settling the government of India; opposed the claims of the Prince of Wales to full power during the Regency; and for a long time refused to bow to the clamour for war against France, but was compelled to yield. He resigned the Premiership in 1801, on the refusal of the King to the measures for Catholic Emancipation, and gradually sank under the grief engendered by the French successes in the war, dying in 1806.

Addington was the son of a physician, and became prominent through the influence of the Pitt family. At the time of Pitt's resignation he was Speaker, but resigned to take the Premiership. He was created Lord Sidmouth in 1804, supported Horne Tooke's claim to a seat in the House of Commons, and promoted without success a bill against dissenters.

Teaching.

Write out notes of a lesson on 'CLIMATE.'

Introduce the lesson by noting the weather of the day, and comparing it with that at other times of the year, and with what they have heard and read of other countries. From the answers given it will be found that different countries have different kinds of weather—that they are hot, cold, dry, or moist according to their situation. The word used to describe the average weather is *Climate*.

Definition, etc. Climate is a word used to denote all the conditions which affect the weather of any district. Derived from Greek *klima*, an inclination, and so used because the weather mainly depended on the varied inclination of the sun's rays on the earth, due to the curve from the equator to the pole.

Chief causes affecting climate of a country.

(*a*) *Position in reference to equator.* Countries between tropics have sun vertical at some period of year—hottest. Further from equator colder it gets. Why? Draw diagram showing less heat received on same amount of surface if rays are oblique.

(*b*) *Height above level of sea.* Colder as we ascend. Why? Rarer atmosphere. One deg. Fahr. decrease for every 300 feet of ascent.

(*c*) *Proximity to sea.* Climate modified by sea-breezes, etc. —moister near sea, drier inland.

(*d*) *Prevalent winds.* From poles, cold; from equator, hot.

(*e*) *Direction of mountain chains.* Intercept hot or cold winds according to direction, rendering country cold or hot.

(*f*) *The general slope of the country.* Whether towards hot or cold region.

(*g*) *Cultivation.* Whether tilled or untilled, covered with forests or treeless.

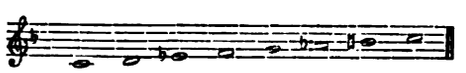
Music.

A quarter of an hour allowed for this paper.

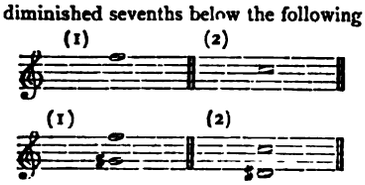
(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write in the Treble clef the ascending scale of C minor, using the minor sixth and the sharp seventh, placing the necessary flats, &c., before the notes :—

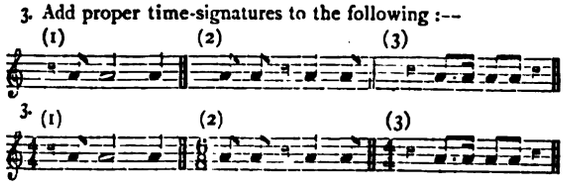
1.



2. Write diminished sevenths below the following notes :—



3. Add proper time-signatures to the following :—



TONIC SOL-FA NOTATION.

1. Write an ascending minor scale from *lah*, to *lah*, using the minor sixth and the sharpened seventh.

1.

l, t, d r m f se l

2. Write diminished sevenths below the following notes :—(1) *fah*'; (2) *doh*'.

2. (1) *se*; (2) *re*.

3. Re-write the following, halving the value of every note. Use two-pulse measure :—

|m :-.f |r : |s :-.f |r.t,:d ||

3. |m .,f :r . |s .,f :r,t,.d ||

Matriculation Hints.

BY HENRY A. REATCHLOUS, M.A. (LOND.), B.Sc.,

Westminster Training College.

WE give a translation of the passages of Greek and Latin set in this journal for May :—

(1) Postumius had with him two Roman legions, and had raised a force of allies on the Adriatic coast, sufficient to put him at the head of 25,000 fighting men when he entered the enemy's country. The Gauls had beset the outskirts of the forest, and when the Roman column entered its precincts, they pushed over the outermost of the trees which had been hewn through. These toppling over one against another on the right hand and on the left, overwhelmed arms, men, and horses in a ruin from which scarce ten souls escaped.

(2) The victory is ours if the gods and the prophets who serve them see aught of the future. Let us then, as men filled with a confident assurance, who feel themselves more than a match for the foe they are about to engage—let us lay aside our pikes and make our swords our only weapons that we wield. Then when their idle shafts are spent, let them see the flashing of your swords; remember, each one of you, that it is the gods that nerve the Roman's arm. (Without the context it is not certain whether *qui-adjuvent* should be translated as above or run thus :—'That these are gods that can nerve the Roman's arm.')

(*a*) Peace, unhappy woman; make not friends afraid.

(*b*) They say that fire, water, and earth, all exist by nature and chance, and none of them by art.

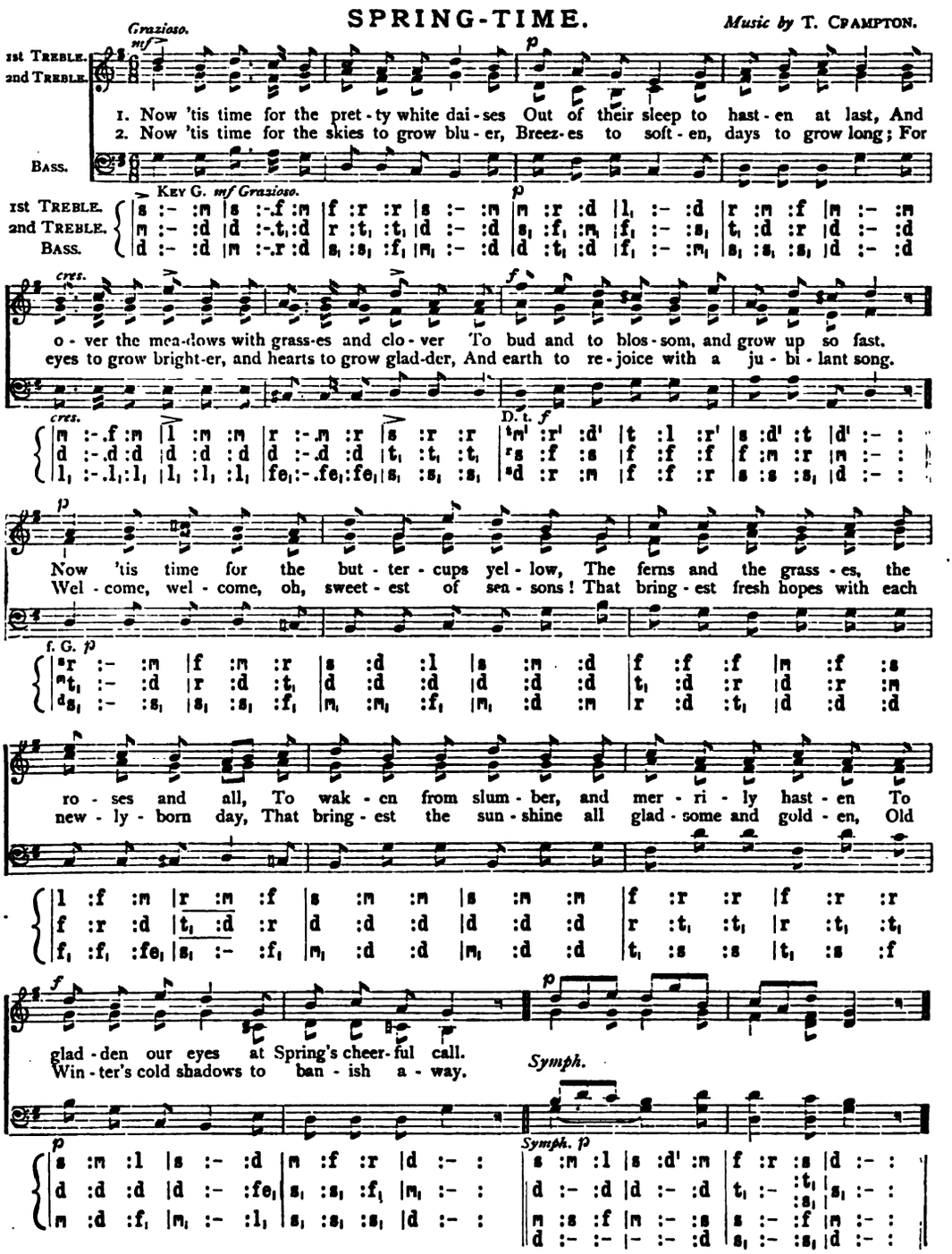
(*c*) That the evidence, then, which has been given is true, I suppose neither this man himself nor any one else for him will be able to show.

(*d*) All the preceding speakers seem to me to felicitate mankind on the good things which they owe to God.

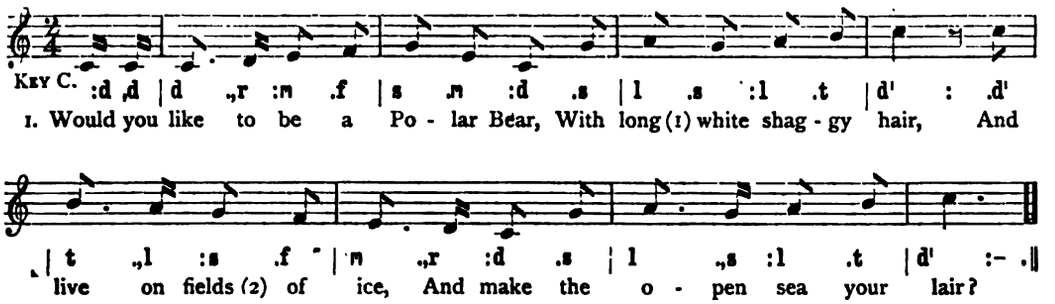
Natural Philosophy.—The quantity of matter in a body is called its **Mass.** Two masses are said to be equal when they would equally stretch a thread of caoutchouc. This stretched string exerts force. Equal masses, therefore, are those which exert the same force. But what is force? Force is defined to be that which changes, or tends to change, the motion of a body. It is plain we cannot measure the amount of a force by the aid of a definition like this, which merely tells us how to decide whether there is any force or not. Force is estimated, then, by the rate of change of momentum per second. Let it be clearly understood that force is always of one and the same kind, and is always measured in the same way as 'time-rate of generation of momentum.' **Momentum** or quantity of motion of a body is defined to be the product of its mass into its velocity; and $= Mv = \frac{ML}{T}$, where the units of mass and length are involved directly, and the unit of time inversely. **Force** therefore $= \frac{Mv}{T} = \frac{ML}{T} \div T = \frac{ML}{T^2}$. In the C.G.S. (Centimetre Gramme Second) system, the unit of mass is the quantity of matter in one gramme. If, then, a force be represented by ten, when the fundamental units are a pound, a foot, and a second, when they are a stone, a yard, and a minute, it would be expressed by $\frac{10 \times 60 \times 60}{14 \times 3} = \frac{36000}{42} = 857.1$.

More candidates fail in *mathematics* than would be expected from an examination of the questions recently set. There must have been a want of careful preparation. But it is well known that those who are pretty well acquainted with the work and can answer the questions as soon as they are out of the room, leave a very sorry performance indeed for the examiner. There is no lack of good text-books. Todhunter's 'Algebra' for beginners, and Hamblin Smith's 'Algebra' will be quite sufficient. In regard to the geometry a few words may be useful; the parts specified are the first four books of Euclid, or the subjects thereof. Those who have only studied Euclid must be reminded that the examiners are not bound to use his phraseology. The candidates should be able to recognise the same proposition though somewhat disguised. The first six books of Euclid by Dr. Casey, is an excellent book, which will repay consulting. To this might be added the syllabus published by the Association for the Improvement of Geometrical Teaching. There is one point of cardinal importance, and that is, working geometrical exercises. This should be done from the first; but beginners are usually discouraged because the exercises they attempt are too difficult for them. A good set of easy riders is often hard to find. The student will find plenty of suitable exercises in Dr. Casey's book, and also an excellent set of easy problems in Mansford's 'Euclid,' to which there is a key published, which may be serviceable to private students i judiciously used.

(*To be continued.*)


SPRING-TIME.
Music by T. CRAMPTON.
Grazioso.
mf
1st TREBLE.
2nd TREBLE.
BASS.
1. Now 'tis time for the pret-ty white dai-ses Out of their sleep to hast-en at last, And
2. Now 'tis time for the skies to grow blu-er, Breez-es to soft-en, days to grow long; For
KEY G. mf Grazioso.
cres.
o-ver the mea-dows with grass-es and clo-ver To bud and to blos-som, and grow up so fast.
eyes to grow bright-er, and hearts to grow glad-der, And earth to re-joice with a ju-bi-lant song.
D. t. f
Now 'tis time for the but-ter-cups yel-low, The ferns and the grass-es, the
Wel-come, wel-come, oh, sweet-est of sea-sons! That bring-est fresh hopes with each
f. G.
ro-ses and all, To wak-en from slum-ber, and mer-ri-ly hast-en To
new-ly-born day, That bring-est the sun-shine all glad-some and gold-en, Old
glad-den our eyes at Spring's cheer-ful call.
Win-ter's cold shadows to ban-ish a-way.
Symph.
Symph. p

THE POLAR BEAR.

Words by C. S. BERE.

KEY C. :d ,d | d .,r :m .f | s .m :d .s | l .s :l .t | d' : .d'
1. Would you like to be a Po - lar Bear, With long (1) white shag - gy hair, And
| t .,l :s .f | m .,r :d .s | l .,s :l .t | d' :- .||
live on fields (2) of ice, And make the o - pen sea your lair?

2.

And jump (3) o'er little frozen hills,
And make ice slabs your seat,
And never slip, because you have
Thick hair upon your feet? (4)

3.

And be as much at home on land
As on the frozen sea,
And watch for walrus, seals, and fish, (5)
As happy as could be?

4.

I don't think I should like that life,
'Twould be so drear and cold; (6)
I'd rather be were fires were near,
And coals were cheaply sold. (7)

5.

So I will let the Polar Bear
Repose in his warm furs;
And be myself, with fires at home,
And puss that always purrs. (8)

(1) Imitate long hair all over body. (2) Move hands in smooth horizontal. (3) Jump. (4) Lift up feet and show the soles. (5) Lean forward as if watching. (6) Shiver. (7) Rub hands and look comfortable. (8) Appear to be nursing and stroking a cat.

ANSWERS TO ARITHMETICAL QUESTIONS IN THE 'SCHOLAR' FOR JUNE, 1884.

STANDARD III.

(1) 484,396,840.
(2) £35,640 18s. 1¼d.
(3) £29,351 14s. 5½d.
(4) £101 0s. 6d.
(5) 5929+40.
(6) £15,612 6s. 7½d.
(7) £14,568 1s. 5¾d.
(8) 38 rows.
(9) 4253.
(10) 9137+37.
(11) £64,055 7s. 0¾d.
(12) 46 books.

STANDARD IV.

(1) 25 gallons.
(2) 259 fur. 3 po. 3½ yds.
(3) £119,160 4s. 2¾d.
(4) £501 0s. 10½d.+72.
(6) £2,611,515 17s. 1d.
(7) £2318 16s. 9½d.
(8) £7 18s. 3¾d.+60.
(9) £100 2s.
(10) 1s. 9d.
(11) 89.
(12) 3150.

STANDARD V.

(1) £87,993 10s. 6d.
(2) 6s. 7¾d.; 18s. 8½d.; £3 4s. 2d.; £10; 16s. 8d.; total, £15 6s. 2d.
(3) £4 7s. 3½d.+60.
(4) £127,810 12s. 3¾d.
(5) 5s. 11½d.; 9s. 9¾d.; 9s. 2¾d.; 7s. 6d.; 11½d.; total, £1 13s. 5d.
(6) ½.
(7) 58 yds. 2 ft. 3 in
(8) 8⅛.

STANDARD VI.

(1) 10 cwt. 1 qr. 9 lbs. 8 oz.
(2) 1⅞.
(3) £703 8s. 3d.
(4) 212·24+
(5) (*a*) $1\frac{5}{6}$; (*b*) 5s.
(6) 147; $3\frac{3}{5}\frac{3}{5}$.
(7) 8 horses.
(8) ·5 or ½.
(9) £5 14s. 4d.

STANDARD VII.

(1) £417 7s. 9d.
(2) 10·98.
(3) £800.
(4) $17\frac{33}{41}$ p. c.

ANSWERS TO ALGEBRA QUESTIONS IN 'THE SCHOLAR,' FOR JUNE, 1884.

EXERCISE XXX.

(1) $x=6$; $y=4$.
(2) $x=2\frac{1}{2}$; $y=7$.
(3) $x=-b$; $y=a+b$.
(4) $x=2\frac{1}{2}$; $y=5$.
(5) $x=25$; $y=49$.
(6) $x=a+b$; $y=a-b$.
(7) $x=10$; $y=24$.
(8) $x=5$; $y=2$.
(9) $x=12$; $y=15$.
(10) $x=\frac{1}{2}$; $y=\frac{1}{2}$.
(11) 25 and 21.
(12) Sheep, £3 each; cows, £22.

ANSWERS TO ARITHMETICAL QUESTIONS IN THE 'LITTLE LEARNER' FOR JUNE, 1884.

STANDARD I.

(1) 1718
(2) 791
(3) 103
(4) 1582
(5) 709
(6) 109
(7) 896
(8) 726
(9) 599
(10) 762
(11) 385
(12) 37
(13) 1009
(14) 404
(15) 266
(16) 636
(17) 682
(18) 79
(19) 641
(20) 183
(21) 469
(22) 539
(23) 213
(24) 188

STANDARD II.

(1) 5,225,684
(2) 3013+5
(3) 9009
(4) 194,039
(5) 167,300
(6) 89,010+8
(7) 2125+6
(8) 49,836,450
(9) 54,289
(10) 28,807+5
(11) 46,303+4
(12) 22,890+7
(13) 12,641,622
(14) 147,810
(15) 21,208,200
(16) 65,692,248
(17) 94,244
(18) 25,821+2
(19) 68,004+6
(20) 18,917,270

Physiology.

BY ARTHUR NEWSHOLME, M.D. LOND.,

Gold Medallist and University Scholar, Physician to the City Dispensary.

Functions of the Pancreas.—The pancreatic fluid enters the small intestine at the same point as the bile. It is a clear viscid fluid, having an intensely alkaline reaction, and containing 2·5 per cent. of solids, of which ·8 is inorganic matter. It contains albumin and a modified casein, leucin, and tyrosin, and a comparatively large amount of carbonate of soda.

Its digestive functions are most important, as it possesses the amylolytic (starch-digesting) power of saliva, the peptonising power of gastric juice, and the emulsifying power of bile (in much greater degree than the latter.)

On *starch*, pancreatic juice acts rapidly, converting it into grape sugar. It converts *proteids* into peptones. In this respect it resembles gastric juice, though there are certain minor differences.

(1) Pancreatic digestion will not go on unless an alkali is present, just as gastric digestion requires the presence of an acid. In fact, 1 per cent. of sodium carbonate in pancreatic juice seems to play the same part as .02 per cent. of hydrochloric acid in gastric juice.

(2) Corresponding to this difference, in gastric digestion the bye-product is an acid-albumin or parapeptone, while in pancreatic digestion it is a body more nearly resembling alkali-albumin.

(3) A third and more profound difference exists. In gastric digestion most of the proteid is converted into peptone; in pancreatic digestion, a large proportion of it is split up into certain bodies, of which leucin and tyrosin are the chief, though there are probably several other bodies, such as fatty acids and volatile bodies. Leucin is amido-caproic acid, while tyrosin is closely allied to benzoic acid. Thus, in pancreatic digestion, a certain proportion of proteid is split up into its constituent fatty acid and aromatic molecules, and other less-known components.

Fats are acted on in two ways by pancreatic juice. They are emulsified; while a smaller proportion is split into the corresponding fatty acid and glycerine.

There are almost certainly *three distinct ferments* in pancreatic juice; one, which is practically identical with ptyalin; a second, to the which the name *trypsin* has been given by Kühne, capable of acting on proteids; and a third, which produces the splitting up of fats. The emulsifying power of pancreatic juice is probably due to the alkali-albumin it contains.

The exact mode of digestive secretion has been more thoroughly worked out in the pancreas than elsewhere. Haidenhain found that after thirty hours' fasting each pancreatic cell in a dog consisted of an inner zone nearest the interior of the alveolus, which was granular, and stained by carmine with difficulty; and a much smaller outer zone, almost homogeneous, and taking carmine staining easily; while the nucleus was placed partly in both zones. During full digestion of food, however, especially about six hours after food, the outer zone became much wider, and the inner zone correspondingly narrower, and the whole cell smaller; while at the end of digestion the original condition was resumed. It seems evident, therefore, that the outer zone nearest the blood-vessels is built up from the blood; while the inner zone is formed at the expense of the outer zone, and the secretion at the expense of the inner zone.

Even during active digestion, there is very little ready-made ferment in a pancreas taken fresh from the body; but there is a body capable of becoming converted into the ferment. To this the name of *zymogen* has been given. Its amount varies with the size of the inner granular zone. For the production of the essential element of the pancreatic juice, it is probable, then, that there are two processes; a production of zymogen constantly going on; and during active digestion, an actual secretion from this of the digestive ferments. The same probably holds good for the other digestive secretions, there being a pepsinogen preceding the formation of pepsin, and a ptyalogen, the formation of ptyalin.

Digestion in the small intestine is chiefly performed by the pancreatic juice, assisted slightly by the bile. The intestinal juice (*succus entericus*) is secreted by the mucous membrane of the small intestine and the small tubular glands in connection with it. Its exact action in digestion is unknown, owing to the difficulty in isolating it, but it is quite subsidiary to the digestive secretions already described.

Summary of the changes undergone by food.—In the mouth some conversion of starch into sugar occurs. *In the œsophagus* the stay is too momentary to allow of changes; though probably a small amount of fluid is absorbed. *In the stomach* the change of starch into sugar is first diminished and then arrested. Proteid materials are broken up and largely converted into peptones. The proteid framework by which starch and fat granules are commonly surrounded become dissolved, the starch and fat being liberated. The thick turbid liquid, called *chyme*, which results from gastric digestion, in about four or five hours after a meal has almost entirely passed through the pylorus into the small intestine. It hardly contains any peptone, but some parapeptone; it is probable, therefore, that the minute veins of the stomach absorb the diffusible peptone, as well as a certain amount of water and salts, directly into the circulation.

In the small intestine the presence of chyme causes active secretion of bile and pancreatic juice, which neutralise its acidity. The conversion of starch into sugar recommences with great activity. Fats are emulsified by the pancreatic juice, and to a less extent by the bile. A certain proportion of fats are split into the corresponding fatty acid and glycerine; and the bile saponifies another portion. The albuminous materials are converted into peptones, but a certain amount is split up into the lower products already named.

The liquids which have escaped absorption in the stomach are absorbed in the small intestine, and with them the peptone and sugar produced as the result of digestion. These enter the blood-vessels directly. The emulsified fat is absorbed into the circulation in a less direct way. The minute fat granules find their way through the walls of the villi, and enter the lacteal vessel in its centre, whence they are carried through lymphatic glands, into the thoracic diet, and thence into the veins at the root of the neck. The term *chyle* is applied to the emulsified contents of the small intestine.

In the large intestine, the intestinal contents which have escaped absorption in their tortuous path along the smaller bowel, assume a more distinctly acid re-

action, a more solid consistence, and a distinctly fæcal odour. Villi are absent from this part of the alimentary canal. It may, therefore, be assumed that the absorption of fats has ceased, though some absorption of liquid may still continue. The acid reaction of the contents of the large intestine is due to an acid fermentation. In the cœcum of herbivorous animals a large amount of digestion goes on, though this is not the case in man. That considerable absorption of nutrient material may occur from the mucous membrane of the large intestine is shown by the fact that patients may be kept alive for a considerable time by the injection of milk and other foods into the rectum, especially if some pancreatic juice has been previously added.

The fæces average about five ounces in the twenty-four hours. They contain the undigested portions of food, such as shreds of elastic tissue, fragments of muscular tissue, fat cells, and starch granules. In addition there are other materials derived from the blood, which may be regarded, therefore, as excretions. The chief of these are ferment-like bodies, mucus, cholesterin, fatty acids, lime and magnesia soaps, excretin, and salts, especially of magnesia. The colouring matter of the fæces is derived from bile. When the latter is deficient the stools become clay-coloured. The distinctive odour of fæces is due to indol, which is developed during pancreatic digestion.

Movements of the intestines.—A stimulus applied to any part of the small intestine produces a contraction of both the circular and longitudinal muscular coats, which travels lengthwise as a wave along the intestine. The circular coat is thicker than the longitudinal, and its contraction has by far the most influence in propelling the food along the intestine. These peristaltic movements may occur independently of the central nervous system. They seem to be controlled by special nervous ganglia of the sympathetic system. In the large intestine the movements are identical in character, but independent, the ileo-cœcal valve separating the two. The muscular fibres increase in strength as the end of the alimentary canal is approached. The rectum is guarded at its orifice by a special development of the circular muscular fibres, called the internal sphincter; while outside this is an additional muscle, known as the external sphincter, which is composed of striped muscle, and under the control of the will. The sphincter of the anus is under the control of a special centre in the lumbar part of the spinal cord, which keeps it in a state of constant tonic contraction. The sphincter only becomes relaxed and the contents of the rectum escape, when the control of this centre is overcome, either by a voluntary or emotional impulse from the brain, or a powerful reflex impulse, due to an over-distended condition to the rectum or other causes.

(*To be continued.*)

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The Discipline of the Mind.

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II.—Observation and the Training of the Senses.

The careful historian of philosophical opinion sometimes finds it hard to determine whether a particular belief is merely lost sight of for a time, or has been definitively abandoned; but there is one item of former metaphysical creeds, in respect of which, I apprehend, doubt would now be out of place—the doctrine, so vigorously combated by Locke and others, of 'Innate Ideas.' It is true the mind's original furniture is still described in various terms by different observers; but whatever be the view taken of our primitive endowments, specific conceptions of either sensible or supersensible realities are certainly no longer held to form any part thereof. Knowledge of all kinds and degrees can only be acquired by more or less conscious elaboration of material supplied to the mind from without. That ideas are often arrived at with a minimum of effort, is owing, not to any reserve of cognitions which it is in the power of more replenished intelligences to bring to light, but (primarily) to difference of inherited nervous organisation, and (secondarily) to the special training to which the youthful mind is submitted. We are, it is true, often startled by the curiosity and readiness of apprehension of very young minds, apparently indicating an appreciation of the significance of problems which in general is patent only to the mature understanding; but in every case a sufficing hypothesis is the reasonable belief that these precocious infant minds, being more finely constructed instruments, respond, but without comprehending their import, to impressions and suggestions which fail to arouse vibrations in duller souls. Were the truth not so frequently ignored, it would seem almost too obvious for remark that there may be great inequality in respect of apprehensiveness, an inequality which may be maintained throughout.

Our stock of ideas I assume, then, to be always personally acquired. I take it to be an error to speak of *a priori* notions, or mental conceptions had before actual converse with the world of things. What is *a priori* is the psycho-physical fabric, the embodied mind, which has been slowly built up by the prolonged reciprocal action of organism and environment. But even such a statement as this does not convey the whole truth. We have further to say, however crude it may sound, that the most delicate feelings, the sublimest imaginings, have a very lowly origin; that the ideal world is really homogeneous, as much of a piece as the material world of the modern believer in the unity of the physical forces. 'There is nothing in mind which was not first in sense,' ran the old dictum. Its modern rendering is almost identical with it: There is no item of consciousness which was not first suggested through sense. Modern psychology has revised the ancient dictum, has enlarged its scope, but contains no firmer principle within the whole range of its teaching.

Now, simple as it may seem when casually proposed, the question, 'What is a sense?' is by no means an easy one to answer. We are apt to think at once of the so-called sense-organs, eye, ear, etc., and to rest contented with the statement: The senses are avenues through which changes in the outer world are reported to the centre of consciousness. And as a first rough approximation this account is not amiss; but when we look a little closer into the matter we see that this said 'outer world' has very hazy limits, and we are puzzled to determine in what category to place certain modes of consciousness which are qualitatively indistinguishable from impressions resulting from affections of a definite sense-organ, although (save by a stretch of language) there is no mediatory organ in the case.

Between the sensation of touch, ultimately produced by some affection of the exposed skin, and a feeling of internal pressure, due to some obscure local cause—between this latter relatively definite sense of uneasiness and the wholly vague feeling of systemic satisfaction or dissatisfaction, what fine degrees, and what consequent perplexities of description and classification! And what has become of the 'organ' which entered into our differentia of a sense? Again, neither retina nor skin, either separately or combined, will be found competent to reveal to us the whole of what we understand by a solid figure; and we are finally compelled either to fall back upon the discredited doctrine of a non-empirical origin for a large number of ideas, or to enlarge the definition of a sense so as to indicate the maximum of resemblances without confusion of mental boundaries.

The latter course is quite practicable, at the cost of departure from uncritical popular conceptions. We have only to declare that a sense is a primary form of pyscho-physical receptivity and activity, specialised by the distribution of the nerve-fibres and their internal endings in nerve-centres.

A purely active sense we do not possess. Our strictly passive senses are numerous: they may be divided into two classes, according as they are awakened by stimuli external or internal to the body. The former would include the senses of colour, sound, odour, taste, touch, temperature; the latter a mass of feeling very difficult to describe in detail, but for the most part closely resembling the vaguest external senses, touch and temperature. It is characteristic of these internal senses that they are little regarded, save when the physical agitation is so great as to induce a marked emotional accompaniment of pleasure or pain. This emotional accompaniment, overpowering their sensuous quality, renders the internal senses of little value as sources of intellectual knowledge, but gives them a pre-eminent value as inciters to voluntary action.

The senses which contribute most to knowledge of the outer world are those which are at once active and passive, the two forms of consciousness being so inseparably united that only a very careful analysis can distinguish the part played by each. The obtrusiveness of the external suggestion has even led to the contribution of the psychical organism being ignored altogether, and popular language reflects an immature psychology when it opposes Sense to Understanding as a receptive to a productive faculty. These mixed senses, as they may be called, are chiefly sight and active touch; a portion of the sensations of hearing, smelling, and tasting, though a comparatively small portion, have also a place here. But it is the eye and the movable members that are the physical parts which chiefly mediate the operation of these compound senses. Consider what amount of knowledge would be possible for a being with an immobile eye and wholly paralysed limbs. Such a being would be stimulated by, or encounter shocks from, the outer world, but it would have no means of distinguishing between the sensations which arose through changes in its own organism, and those which resulted from changes in a contrasted Nature. By being able to initiate movement a normal human being, however, obtains a view of the world immeasurably more precise and proportioned. He is able, by varying his efforts, to estimate the consistency of the objects which surround him, by lifting them to form an idea of their weight, and by rotating his eye-balls to obtain pictures of infinite variety in an incredibly short space of time. In short, instead of regarding himself as but a conscious thing, blown about by every wind of outward circumstance, he can adequately distinguish, if he tries, between the sphere of his personality and that larger world which is set over against, and in contrast to, him, and whose attributes are only to be detected by the exercise of nice observation and discrimination.

To resume. All notions or derivative constituents of consciousness are either revived sensations, or compounded sensations, or abstracted sensations. The proof of this assertion can only take the negative form, disproof of alleged exceptions. But by Sensation must be understood much more than is usually thereby signified; it must be taken to include all modes of feeling and action undecomposable according to the most rigorous inspection.

Turning now to practice, it is evident that the *training* of the senses will include (possibly) the providing appropriate stimuli for sensuous reaction, and (certainly) the seconding of the mind's efforts to gain command of the material offered it, always in obedience to the ideal end of the efficiency of the individual as a member of a community progressive in its hopes and desires. Humble as the office of disciplining the senses may be, one cannot help seeing that its effective discharge lies at the root of all human progress. Over-stimulation here, atrophy and neglect there, will pervert the nature, and be the source of numberless failures and regrets in after life. This is sufficiently apparent in the case of abnormal sense-faculty, as when there is a malformed organ of sight or hearing; but the same fact holds good of unused senses generally, and had we always the skill to detect the subtile links of the causal chain, we should doubtless note in the aberrations of the mature mind the fruit of a lack of attention or of confused perceptions uncorrected in the nursery or the primary school.

We here come, however, to a point where a fundamental difference of opinion has to be signalled, which may as well be taken notice of now, although its application is to the whole range of mental culture. I allude to what might be termed the *anarchical* and the *paternal* views of early education. There is seemingly a natural tendency in the pedagogic mind to gravitate to one of these extremes, to exalt the child's ability to find right roads by itself, or to anxiously watch the early development, as if in the absence of the cultivator's eye only worthless weeds would burden the soil. The limitless virtue of direct instruction is the presupposition of the latter school, leading to a painful attention to detail and a multitude of prescriptions which fetter all original development. On the other hand it is scarcely open to doubt that the youthful mind, left almost entirely to itself, will seek pleasant paths—often to its own detriment—and lose chances of strengthening its powers which never can be regained. As a desirable reaction against over-government this latter tendency is good, and if we modify it thus,—the child should be left to run alone, or find its own way, up to the point of exhausted effort, or the limit of positive error,—the principle may stand as a wise one, a useful restraint on disciplinary formalism.

The view here taken may be otherwise indicated as follows:—All methods of education are more or less artificial. It is desirable, however, that this artificiality should be minimised, and that for several reasons.

Discipline is only a means to an end; the end in the present case being exercise of faculty in a real world beyond the reach of radical change, whose work has to be done, and not our private will. The period allowed for mental gymnastics being brief, it is desirable that the utmost should be made of so short a preparatory season, and the only way to fulfil that requirement is to assist Nature as far as possible, and take advantage of the opportunities she spontaneously offers. Now rapid progress is only possible under two conditions, the one negative, the other positive—that we do not attempt to anticipate the growth of the mental powers, and that we obey the hints afforded by the possession of a faculty, and rather supply the means for its expression than neglect it for the sake of what we deem some superior power. In short, the school should as much as possible be the real world in miniature, and supreme regard should be paid to that guide which achieves success in the real world—the 'Law of Interest.'

We have in the sports of children a striking monition to keep as close to nature as possible in our artificial systems. It has been repeatedly remarked that as severe toil is undergone in *play* as in serious labour, but it is cheerfully undergone because the normal powers are left to be freely exercised, and natural cues are given to observation and attention. Here are exemplified the contests and occupations which will afterwards be entered upon under other names, and for which there is an organised proclivity, owing to the protracted adjustments of ancestral habit. In this mimic state all is concrete. If the scenery is barren, the child replenishes it with ideal stores, constructing palaces and citadels out of chairs and tables, and transforming sticks and ill-shaped puppets into prancing steeds and heroic men and women.

But it will be said the very object of discipline is to draw away the mind from this spontaneous and exuberant concreteness, to induce reflection and the acquisition of powers of generalisation. Undoubtedly; but how? Not by doing the child's work, or worse still, applying results which have only been obtained by years of abstract culture, striving to 'put old heads on young shoulders,' but by leaving the child to perform its own analysis, and seconding, but not superseding, its efforts. Surely the great economic law, which has borne such excellent fruit in commercial industry is worthy of prime consideration in education, to attain results with the least cost, and the best results are ever obtained where there is the least coercion, and where the goal of abstract thought is reached by easy stages.

To apply these remarks to our immediate subject. The first education should represent a 'masterly inactivity' on the part of the instructor. Let the child first teach its tutor. Let the latter rather practise the art of observation, and permit the child's glances to roam at their own sweet will. Little by little the gaze will get steadier, this or that object will fascinate the mind, and an opening will be given for the control of Attention.

There are three leading types of character answering to the three varieties of sensibility. There is the subjective mind, whose interest is prevailingly claimed by its internal or organic sensations; the passive or sensuous nature proper, which is chiefly allured by the pleasures of the palate, and the beauties of colour and of tone; and the active temperament, which is favoured by a strong muscular development, and which, by preference, reacts on its environment, and loves to assert itself in opposition to the passive and active resistances of its surroundings.

The first of these dispositions will early claim the thoughtful care of the skilful trainer. Although it cannot be denied that there are the possibilities in a nature so endowed of unfolding a character superior to that of the other two, the unforeseen outward shocks to which the introspective nature is exposed render such a self-centred constitution anything but a desirable possession for the individual himself. The art of the trainer in this case will lie in trying, as we say, to draw the individual out of himself, to strengthen the external regards by exaggerating the objects of outward sensuous apprehension, and by repeating the stimulus sufficiently often to prevent the inevitable relapse at the first opportunity into the subjective attitude. Above all, those mixed sensations in which activity is most manifest should be sought to be aroused, an end which can best be gained by presenting curious objects to be handled, or by investing visible forms with pleasing accessories. It is of little avail to exhibit bald specimens, concrete-abstracts, as they might be termed—the subjective mind is either listless or speedily diverted—but rather natural or artificial objects in which the wealth of the concrete is not spared. When the subjective bias is corrected, and the habit of attending to outward objects is established the severer forms may be offered to the view.

The sensuous temperament, as it may be styled, to conform our phraseology as far as possible to the popular language, is, in a way, intermediate between the subjective and objective temperaments proper, and its discipline would be regulated according to its strength. Taste, as being partially an organic sensation, is too universal an endowment to receive a special correction in one mind more than another. The fondness for sweetmeats is as much a propensity of the objective temperament as of the dreamy nature, and neither sex nor age seems to be a stranger to these delights. With regard to these 'lower' senses of taste and smell but little has hitherto been done for their cultivation; we are apt, perhaps, to ignore their regulation even too much. The ascetic Spartan schoolmaster (ascetic not always on Spartan principles, it is to be feared) is responsible for not a little of the inordinate craving for injurious delights in early years, and the excesses of a later period; and a fastidious palate is regarded by not a few strong-minded parents as a something to be suppressed rather than respected. But surely the sensations of taste enter largely into the legitimate pleasures of life, and one of the marks of a refined mind is a selective taste. The same may be said with regard to odours, though here there is no pretence of a regimen, and it has hardly yet entered into the mind of pedagogue to conceive the regulation of this rather despised sense.

When we speak of the training of the senses, we usually think exclusively of vision, hearing, and touch, and with a passing plea for the non-neglect of other sensibilities, I pass to their consideration.

The sensuous temperament has usually a strong susceptibility to the brilliancy of colour, and our means of gratifying the appetite are rarely equal to the faculty of appreciation. A superior natural endowment for colour is announced not so much by its quick stimulation by depth of hue, as by its selection

of certain colour-combinations. That there are harmonies of colour, as of tone, is almost certain; but the eye is not usually so well instructed by nature on the matter as the ear, and the theory of chromatic æsthetics is in a somewhat backward condition. On the evolution hypothesis, the child, of course, is more readily thrilled by combinations which have been most frequently presented in ancestral experience, and it is not improbable that future art may generate new tastes for colour-combinations which are felt by us as disagreeable. The relations of the chromatic scale have not the same definiteness that is possessed by the acoustic, and the teacher must be content to rely largely on tradition in his search for rules for training this endowment. But there will be no dispute about the necessity of apportioning the depth of the tints to the keenness of the sensibility, the effectiveness of the discipline being measured by the capability of lowering the tone without losing the interest. To be stimulated by grey or neutral tints is the mark of greater susceptibility or protracted training.

With regard to Tone, the instinctive pleasure is here very unequal. There is a musical sense in most; but I have noticed what, if the language were not unscientific, would be called a most capricious distribution of this sensibility. Up to a certain point the susceptibility to rhythm is strikingly characteristic of the subjective temperament (as illustrated by the fondness for lyrical poetry); then there is the delight of revelling in the luxury of tone by natures which can hardly be classed either as introspective or as objective; and, lastly, a high musical taste is often found possessed by very active temperaments, which have little relish for other passive enjoyments. I am not aware that psychology has yet explained these strange conjunctions, which are doubtless ultimately grounded on the unique character of the auditory sense, as at once a highly emotional and a highly intellectual sense.

Under any circumstances, the schools of the future will remedy the gross neglect of the auditory sense which has marked the irrational methods of bygone education. When it is considered what a high social sense Hearing is, how it is hardly possible to enjoy it in solitude, and what simple conditions are required for diffusing its delights, there can be no doubt about the place its cultivation should occupy in a rational curriculum. What discipline there has hitherto been has often been fatally misplaced, however, and probably more tears have been shed over ill-given music lessons than over any other branch of youthful instruction. Simple indifference often deepens into disgust, through a disregard of all psychological law, and an attempt to require performance of compositions which could not possibly be appreciated without a considerable evolution of the perception of tonic relations. As regards vocal discipline, a plea must be put in for the elocutionary training of the ear, the art of reading, an art which is popularly supposed to come by nature, judging by the little time devoted to it in most seminaries, though probably there are a dozen fairly good singers for one tolerable reader. The sense of touch is so largely muscular that it may best be considered in the next paragraph.

We come then to our third group, the objective or active dispositions, that is to say, where the tendency to throw the regards outwards is at its maximum. The senses we have to deal with here are mainly those of sight and touch—sight and touch, *i.e.*, as combining receptivity and activity. The persistent properties of the object-world are apprehended through these mixed senses. They are extension, inertia, hardness, and weight. Where the relevant sense-endowment is large, there is the material of the making of a mathematician or student of physical nature. Where the faculty is weak, the cost of acquisition is usually enormous, a cost aggravated as usual by bad methods. It is not uncommon to find a boy utterly helpless at the elements of geometry, who is yet endowed with large brain power that may hereafter enable him to influence the national destinies. However weak the native faculty, however, there is no doubt that more might be done by bringing form-relations into greater prominence than is done in Nature. Nature, although mathematical in essence, is not obtrusively so; and the methods of art have here to detach the sensuous aspects which the passive temperament seizes upon, and to thrust upon the notice lines and angles in all their nakedness and severe symmetry. So with the general facts of mechanics, which are repulsive and difficult enough to the self-conscious temperament. Physical science requires a large attention to bare form, and hence so few excel at the same time in science and literature, the latter being related to the subjective bias. But the lack of native interest may be compensated by a gentle constraint to closer contact with the object-matter. If a hint might be given to the open-minded here it would be to form the defectives into an awkward squad, and by no means to allow a mechanical genius to be present to put the other members out of countenance. Emulation is undoubtedly good, but it is ignoring the limitations of a sound principle when the much and the little endowed in any direction are brought together in the same class. If the pre-eminence be too pronounced, the feebler members simply relapse into indolence through sheer despair. But there is no knowing what might be done in the way of remedying defective powers if the wise instructor were to set his class of equal defectives to work on very simple things, simple almost to insignificance, and then without the discouragement of failure, slowly train them to excellence. For in all this matter of elementary training we signally err by being too little inclined to stoop to the infirmities of human nature. The genuine trainer will think nothing too elementary or familiar, will smile at no depth of simplicity, and frown at no amount of awkwardness. What, in presence of the infinite unsolved riddles of the world, is the vaunted knowledge of our greatest scientists?

The 'muscular' senses form the best training-ground for the art of observation. Our standards of reference are the sensations procured through eye and hand. We measure the flight of time by the passage of the indicators on the clock-dial, and our nice estimate of degrees of force is, after all, reducible to certain exerted or resisted pressures. The conditions of accurate observation cannot, however, be stated without reference to higher powers of mind than those with which we have as yet become acquainted. Far more than keenness of perception and nicety of discrimination is needed to constitute a good observer. The supreme difficulty is to eliminate bias and the forward leap of the mind; and bias and the anticipatory instinct are always present, although a many-sided culture may do much to reduce the evil. General cultivation of the mind will be found to tell upon the

power of observing, but as far as direct training goes, the cultivation of the faculty of observation is equivalent to establishing a habit of nice distinguishing.

Misled by erroneous notions of human dignity, older pedagogic methods have endeavoured to overleap the first stage of Nature's culture, and to give a training of *con*ceptions before and in place of that of *per*ceptions. Hence the inevitable youthful aversion to school-exercises. As the laws of mind are better understood, all this will be remedied, and a duly-balanced sensuous life will be seen to be the best preparation for the life of reflection and rational inference. The wise poet does not ask too much from his ideal youth when he sings:—

'He must be musical,
Tremulous, impressional,
Alive to gentle influence
Of landscape and of sky,
And tender to the spirit-touch
Of man's or maiden's eye.'

(*To be continued.*)

Query Column.

RULES.

1. Each correspondent is restricted to *one question.* We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.

2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.

3. ☞ **When a pseudonym is adopted it should be written at the end of the query, and the real name and address on a separate piece of paper.**

4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.

5. Replies will not be sent through the post.

6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—'*The Query Editor*,' *The Practical Teacher, Pilgrim Street, Ludgate Hill, London, E.C.*

Arithmetic.

1. DERWENT.—Rules for obtaining the results of $(3794)^2-(3744)^2$ and $(164369)^2-(164119)^2$. (*Certificate Examination*, 1866.)

$$x^2-y^2=(x+y)(x-y).$$

$$\therefore (3794)^2-(3744)^2=(3794+3744)(3794-3744)$$
$$=7538\times 50$$
$$=753800\div 2$$
$$=376,900.$$

$$\therefore (164369)^2-(164119)^2=(164369+164119)(164369-164119)$$
$$=328488\times 250$$
$$=328488000\div 4$$
$$=82,122,000. \text{ Ans.}$$

2. SEMAS.—The interest on a certain sum of money for two years is £71 16s. 7½d., and the discount on the same sum for the same time is £63 17s., simple interest being reckoned in both cases. Find the rate per cent. per annum and the sum. (*Brook Smith.*)

The difference between the simple interest and the discount is the simple interest on the discount.

£	s.	d.
71	16	7½
63	17	0
2	7	7½

£ s. £
∴ 63 17 : 100 :: 3 19 9½ : Rate per cent.
20 20
1277 79
12
957
4
3831
75 3
= 3831/1200 £
12×4
= 6¼ per cent. Ans.

£ £ s. £
∴ 12½ : 63 17 :: 112½ : Sum
2 2
25 225
9
= £574 13s. Ans.

Note.—Another method of solution was given in a previous number.

3. M. GIBSON.—In a bag are 90 shillings, 100 sixpences, and 120 fourpennies; find least number of threepennies that must be added, so that the whole may be distributed in sums of eighteenpence, no such sum being made up of any one coin exclusively.

90 shillings require 90 sixpences,
∴ there are left 10 sixpences;
120 fourpennies = 40 shillings,
∴ 40 sixpences are required;
∴ 30 sixpences or 60 threepennies must be added. Ans.

4. FILIUS NULLIUS.—£12,540 is to be divided in shares among three persons—A, B, C. A is to have ⅔ of B's and C's shares, and B is to have ⅗ of A's and C's shares. What are the shares of each?

A's share = ⅔ of B's share + ⅔ of C's share,
B's ,, = ⅗ of A's ,, + ⅗ ,, ,,
∴ A's ,, = 7/7 of 2/3 of A's share + 7/7 of 2/3 of C's share,
+ ⅔ of C's share,
= 9/21 of A's share + 9/21 of C's share + ⅔ of C's share,
A's share − 9/21 of A's share = 9/21 of C's share + ⅔ of C's share,
12/21 of A's share = 11/21 of C's share,
∴ A's share = 11/12 of C's share.

B's share = ⅗ of (A's share + C's share)
= ⅗ of (11/12 of C's share + C's share)
10
= 2/3 of 23/12 of C's share.
19
= 23/57 of C's share.

A's share + B's share + C's share = £12,540,
∴ $\frac{11}{19}$ of C's share + $\frac{38}{57}$ of C's share + C's share = £12,540,
$\frac{33+20+57}{57}$ of C's share = £12,540,
$\frac{57}{57}$ of C's share = £12,540,
∴ C's share = £12540 × $\frac{57}{1140}$
= £(114 × 57)
= £6,498.

A's share = $\frac{11}{19}$ of C's share
= $\frac{11}{19}$ of £6,498
= £(342 × 11)
= £3,762.

B's share = $\frac{20}{57}$ of C's share
= $\frac{20}{57}$ of £6,498
= £(114 × 20)
= £2,280.

5. FELIX.—Of all the odd numbers between 1,000 and 2,000, which two have the greatest common measure, and what is that common measure? (*Matriculation*, 1873.)

The greatest common measure will be contained in the two numbers 3 and 5 times respectively;
∴ Larger No. = 2000 − 5
= 1995;
Smaller No. = (1995 ÷ 5) × 3
= 399 × 3
= 1197.
Greatest common measure = 399.

6. MAGISTER.—If the alloy in a shilling be $\frac{1}{12}$ of its mass, and the coin be worth a farthing if it were all alloy, what would be its exact value, if it were all pure silver?

Part alloy = $\frac{1}{12}$, part silver = $\frac{11}{12}$;
∴ Value if all pure silver = (1s. − $\frac{1}{12}$q.) × $\frac{12}{11}$
= $\frac{12}{11}$s. − $\frac{1}{11}$q.
= 1s. 1d. − $\frac{1}{11}$q.
= 1s. $\frac{2}{11}$d. − $\frac{1}{11}$q. Ans.

7. ANIMALCULUM.—If 29 oxen would eat up a field of grass in 7 weeks, or 25 oxen would eat up the same field in 9 weeks, the grass growing uniformly, how many oxen would do it in 6 weeks? (*Colenso.*)

The quantity eaten in 9 weeks by 25 oxen would last (25 × 9) or 225 oxen for 1 week;
The quantity eaten in 7 weeks by 29 oxen would last (29 × 7) or 203 oxen for 1 week;
∴ Quantity grown in 2 weeks would last (225 − 203) or 22 oxen for 1 week;
∴ The growing grass supplies 11 oxen.
∴ No. of oxen to eat the grass of the field in 6 weeks
= {(29 − 11) × $\frac{7}{6}$} + 11
= (18 × $\frac{7}{6}$) + 11
= 21 + 11
= 32. Ans.

8. TRENCHWOOD.—A bookseller devotes a sum of money with its contingent profits to the purchase and re-purchase of stock. At the end of every three months he re-invests his returns. His profits are $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{7}$ of his respective investments. Show that at the end of the year his capital will be doubled.—(*Barnard Smith.*)

Capital at end of year
= $\frac{8}{7}$ of $\frac{7}{6}$ of $\frac{6}{5}$ of $\frac{5}{4}$ of original capital.
= Twice original capital.

9. VERNON.—A merchant sells a horse at a loss of 4 per cent.; had he sold it for 6 guineas more, he would have gained 5 per cent. Find original cost. (*Mansford.*)

Suppose cost price were £100,
Then, selling price in 1st case = £96,
And, " " 2nd " = £105:
Difference between the two selling prices = £105 − £96
= £9;

£ £ s. £
∴ 9 : 6 6 :: 100 : Original cost.
20 20

180 120
7

= £70. Ans

10. BRUTUS.—If a piece of work can be done in 50 days by 35 men working at it together, and if, after working together for 12 days, 16 of the men were to leave the work, find the number of days in which the remaining men could finish the work? (*Barnard Smith.*)

men men days
35 − 16 : 35 :: 50 − 12 : Time to finish the work.
men men days
19 : 35 :: 38 : Time.
2
= 70 days. Ans.

11. SCOTTIUS.—$\frac{3}{4}$ of $\frac{11}{12}$ of a cask of sugar cost 44s., and when the grocer had added on one sixth of the cost price, it was retailed at 3½d. per lb. What was the weight of the cask?

Cost price per lb. = $\frac{6}{7}$ of 3½d.
= 3d.;
$\frac{3}{4}$ of $\frac{11}{12}$ of the cask cost 44s.,
$\frac{33}{48}$ " " " ",
∴ Cask cost 105s.;
∴ Weight of cask = (105s. ÷ 3d.) lbs.
= (105 × 4) lbs.
= 420 lbs.
= 3$\frac{3}{4}$ cwt. Ans.

12. BRUTUS.—A watch is 10 minutes too fast at 12 o'clock (noon) on Monday, and it gains 3′ 10″ a day; what will be the time by the watch at a quarter-past 10 o'clock a.m. on the following Saturday? (*Barnard Smith.*)

Time from Monday 12 o'clock (noon) to Saturday 10 15 a.m. = 118½ hours;

hrs. hrs. min. sec.
∴ 24 : 118½ :: 3 10 : Time gained.
4 4 60

96 473 190
48 95 95

2365
4257

48)44935(936
432

173
144

295
288

7

= 936$\frac{7}{48}$ sec.
= 15 min. 36$\frac{7}{48}$ sec.;
∴ Time by watch = (15 min. + 10 min. + 15 min. 36$\frac{7}{48}$ sec.) past 10
= 40 min. 36$\frac{7}{48}$ sec. past 10. Ans.

13. DOMINUS.—A person bought goods on the continent; the cost of freight and insurance was 15 per cent., and that of duty 10 per cent. on the original outlay; he was obliged to sell them at a loss of 5 per cent., but if he had made £3 more of them, he would have gained 1 per cent. What was the original outlay? (*Barnard Smith.*)

Suppose original outlay were £100,
Then total cost = £125;
Loss of 5 per cent. = 5 % on £125
= £6 5s.,
Gain of 1 per cent. = 1 % on £125
= £1 5s.;
∴ Difference between the two selling prices
= £6 5s. + £1 5s.
= £7 10s.;

£ £ £
∴ 7½ : 3 :: 100 : Original outlay.
2 20

15
5

= £40. Ans.

14. R. E. C.—The Compound Interest on £250 for 2 years is £20 8s. What is the rate per cent?

Amount of £250 at end of 2 years = £270·4,
" " £1 " " = £270·4 ÷ 250
= £1·0816;

Now, $\sqrt{1\cdot0816} = 1\cdot04$;
∴ Amount of £1 for 1 year = £1·04,
" £100 " = £104;
Rate per cent. = 4. Ans.

15. RUFUS.—A and B enter into partnership; A contributes £5500 and B £3500. The agreement is that £120 is to be put by as an insurance fund annually, and the remaining profits to be divided in proportion to the capital subscribed. At the end of the year A gets £435 8s. 4d. Find the percentage of the whole profit. (*Piper's* 'Advanced Arithmetic.')

Total capital = £5500 + £3500
= £9000;

£ £ £ s. d.
∴ 11 : 11 :: 11 8 4 : Amount divided.
11 18 39 11 8
18
£712 10 0

Total profit = £712 10s + £120
= £832 10s.;

£ £ £
∴ 2 : 11 :: 832½ : Percentage of whole profit.
2 2
11
37
= 37/4 £
= 9¼ per cent. Ans,

16. WELSHMAN.—A merchant begins a ready-money business with a borrowed capital of £10,000, for which he pays 5 per cent. per annum. He turns over his capital twice a year, and his profits are 6 per cent. Allowing him 2 per cent. and the interest on his profits for expenses, how soon will he have paid off the debt? (*Davis.*)

Net Profit = {(6 × 2) − 2} per cent. of capital
= 10 per cent. of capital;
Amount saved annually = (10 − 5) per cent. of capital.
= 5 per cent. of capital;
∴ Capital will be saved in 10/5 years
= 20 years. Ans.

17. FELIX HOLT.—A person shooting at a target at a distance of 500 yards, hears the bullet strike the target 4 seconds after he fired. A spectator, equally distant from the target and the shooting-point, hears the shot strike 2½ seconds after he heard the report. Find the velocity of sound.

Velocity of sound per second
= 500 yards / 4 − No. of seconds for bullet to strike the target
= 500 yards / 4 − 2½
= 500 yards / 1½
= 1000/3 yards
= 1000 ft. Ans.

General.

1. SOLICITOR.—(1) Your query is stated incorrectly. Please repeat it. (2) Bacon's Essays, fully annotated, appeared in the PRACTICAL TEACHER, Vol. III. Sent carriage paid for 7s. 6d.

2. BLACKBOARD and MOSES.—The solutions of your queries have already appeared in the PRACTICAL TEACHER. See previous numbers.

3. NANCE.—(1) How much fluid is contained in the pleural cavities, and how is it renewed?

In the normal condition the two surfaces of the pleural cavity are in contact, so that in the greater part of the pleura no cavity exists. It is only in diseased conditions that these surfaces become separated by an effusion of fluid. In the natural condition the pleural fluid only amounts to an ounce or two. This is renewed by exudation of serum from the blood-vessels of the pleura; it is removed by the stomata which stud the surface of the pleura, by which the pleural cavity communicates with the lymphatic vessels.

(2) How is hearing possible in the absence of the small bones of the ear?

In order that sound vibrations may be received by the auditory nerve, it is necessary that the fluid of the internal ear should be set in vibration. As a rule the small bones of the ear serve chiefly to carry sound to the internal air. In their absence, however, it may be communicated by means of the air of the tympanum to the membrane covering the fenestra rotunda admitting to the internal air, and thus the sensation of sound may be received.

(3) What are the chief chemical differences expected to be found in the liver of a starved animal and a well-fed one preceding death?

The liver in a well-fed animal contains considerable fat and a large amount of glycogen stored up. In a starved animal, these stores would be gradually exhausted.

4. ANXIOUS. — The questions were published in the *Schoolmaster* in December last, and are issued officially by Longmans, 6d.

5. ANXIOUS. — As you were apprenticed for four years you should have taken first year's Papers. The Agreement might have been for three years, as you will be 'over 18' by that time. (See Schedule V.) The Department cannot recognise private agreements.

6. SYD's writing is irregular; he should practise in good copy-books. When he enters College he must pledge himself to teach in Great Britain. Apply to the Agent-General of any Australasian Colony, Victoria-street, Westminster.

7. FREEMAN is at liberty to write his notes as he pleases; but they should exhibit some method.

8. SUNDERLAND'S French will be understood if he will wait for an opportunity to get the pronunciation from the 'living voice.' In the meantime he may read French. The pronunciation cannot be wholly given in English equivalents. Large hand very poor; small hand good.

9. TE DUCE.—Curwen's 'No. 4,' or Hullah's 'Time and Tune.' You give no large-hand specimen. This greatly helps to determine the marks.

10. MONITOR will find the needlework named in the Code Schedule III.

11. CICERO's writing should be rounder. Its regularity would gain seventy per cent.

12. W. FLETCHER.—(*a*) In wheeling the material away you have both backwards and forwards to go, or 20 × 2 = 40 yds.

(*b*) The word 'hoped' is transitive, having the noun-sentence 'he would meet me,' as the object.

13. E. PEGRAM.—The answer given is wrong, and £1,575 is the correct result.

14. WILLIAM WALLACE.—If you understand the 'Torrid Zone' to mean that section of the earth lying between the parallel planes of the two tropical circles, you must, in order to find its weight, determine the ratio of its mass to that of the whole globe.

15. ZERO.—A Pupil Teacher must complete his engagement according to his agreement (Schedule VI). If apprenticed for only three years he may sit at the Admission Examination (by permission) during his third year.

16. SELRAHC YALS can see in Schedule V., under 'Additional Subjects' that marks are allowed for not more than *one* language and *one* science.

17. ELLA HARRISON.—The science questions were published in *The Schoolmaster* in 1883. They may be had in another form on application to Mr. H. R. Major, Leicester.

18. DON CÆSAR should inquire of the supervisor as to his individual case. Handwriting not approved: it is not round enough.

19. G. P. R. writes small-hand fairly well; sends no large text Inquire at the Department, Whitehall.

20. IGNORAMUS. — $3\frac{3}{80}$d. = 3d. + $\frac{27\times4}{80}$ farthings = 3d. + $\frac{108}{80}$ far. = 3d. + $1\frac{28}{80}$ far. = 3d. + $1\frac{7}{20}$ far.

21. W. B. STEER.—As you point out, the second answer to the fourth sum in Arithmetic (Third Year, Males) in our March issue should be 4s. 6d., and not 6s. 9d.

22. LIZZIE.—

Sentence.	Kind.	Con. nec- tive.	Subject.	Predi- cate.	Ob- ject.	Extension.
(*a*) But my soul wan- ders.	Prin. sent. Adv. to preceding sent.	But	my soul	wanders		
(*b*) I demand it back to meditate amongst decay, and stand a ruin amongst ruins, there to track fall'n states and buried greatness o'er a land the master mould of Nature's hea- venly hand.	Prin. sent.		I	demand	it	back to me- ditate amongst decay and stand a ruin amongst ruins, there to track fallen states and buried greatness o'er a land, the master mould of Nature's heavenly hand (pur- pose)
(*c*) Which was the mightiest in its old command,	Adj. S. to 'land' in *b*		which	was the mighti- est in its old com- mand		
(*d*) And is the love- liest,	Adj. S. to *land* in *b*	and	which	is the loveliest		
(*e*) And must ever be,	Adj. S. to *land* in *b*	and	which	must be the love- liest		ever
(*f*) Wherein were cast the heroic and the free, the beautiful, the brave, the lords of earth and sea.	Adj. S. to *land* in *b*	where- in	The heroic and the free, the beautiful the brave, the lords of earth and sea	were cast		wherein

23. X. Y. Z.—(1) Your reasoning and method of working are correct, but you must have made an error in working it, as the result is 1567·0468659 sq. in. (2) We do not know of a book such as you mention.

24. MOSES.—Your query was solved in our issue for May, 1882.

25. BLACKBOARD.—You will find the solution of your query in our issues for September, 1882, and December, 1883.

26. W.H.M.—The solution of your query appeared in our issue for July, 1882.

27. ORDER.—These are impossible questions. You do not say what examinations.

(1) *Deschanel's.* Blackie.
(2) *Silvanus Thompson's.* 4s. 6d. Macmillan.
(3) *Student's Hume.* Murray.
Green's 'History of the English People.' Macmillan.
(4) *Smith's* 'Latin Grammar.' 6s. Murray.
Roby's 'Latin Grammar.' Macmillan.

28. J. J. JACKSON.—

(1) *Jamieson's* 'Scotch Dictionary.'

(2) *Halliwell's* 'Dictionary of Archaic Words.' Can be seen at most libraries.

29. WALTER LE MASURIER.—

(1) *Rushbrook's* 'First Greek Reader.' (Clarendon Press.) Macmillan.

(2) Suitable books for other subjects will be mentioned in due course.

30. PUZZLED.—You will find the solution of your query in our issue for October, 1882.

31. ABBOTT.—(1) The solution of your query appeared in our issue for May, 1882. It is a question in mensuration, not arithmetic. (2) As you state, your writing lacks firmness.

32. POMPEY.—(1) The abbreviation you mention may be used as it states:—'All generally understood abbreviations for *words* may be used.' (2) Perhaps ninety per cent.

33. PERPLEXED.—The solution of your query appeared in our issue for March, 1883.

34. EMERALD.—You *must* have copied your query *incorrectly*. Will you please repeat it?

35. LEARN.—(*a*) Your writing, if a little rounder, would get the full precentage of marks.

(*b*) In a far different manner did the silent Oneyda accept the offered cup of friendship and the pipe of peace. His face exhibited no more signs of feeling than that of a bronze statue. Pity may have moved his soul, but all signs of it were wanting in his countenance. Trained during the whole of his life, from the time when his cradle was swung from the branch of a tree till the end of his days, to endure without a sign the greatest of good or ill, and to be ashamed only of feeling fear, he was a passionless child of the woods, a being to whom tears were unknown.

(*c*) *Bronze*—noun, com.. neut., sing., nom. to 'is unchanged.'
unchanged—participial adj., qual. 'look.'
soul—noun, com., neut., sing., 3rd, nom. after 'was.' (His was a soul.)
that—rel. pro., neut., sing., 3rd., obj., gov. by 'touched.'
shook—verb, irreg. trans., act., ind., past, 3rd, sing., agreeing with its nom. 'pity.'
extreme—noun, abs., neut., sing., 3rd, obj., gov. by 'to brook.'
good—adj., used as abs. noun, neut., sing., 3rd, obj., gov. by 'of.'
impassive—adj., used as adv. of manner, qual. 'to brook'; *or*, adj. of quality, qualifying 'soul.'
fearing—pres. part. of 'to fear,' refg. to 'soul.'
but=only—adv. of manner, qual. 'fearing.'

36. CLOCAENOG, Ruthin.—Parse the words underlined, and analyse the last five lines in the following passage:—

'*Thus* with the year
Seasons return, *but not* to me returns
Day, *or* the sweet approach of even or morn,
Or sight of vernal bloom or summer's rose,
Or flocks, or herds, or human face *divine;*
But cloud *instead*, and *ever-during* dark
Surrounds me, from the cheerful ways of men
Cut off, and for the book of knowledge fair
Presented with a universal blank.
Of nature's works to me *expunged* and rased,
And wisdom at one entrance *quite* shut out.
So much the rather thou, celestial Light,
Shine inward, and the mind through all her powers
Irradiate; there plant eyes, all mist *from thence*
Purge and disperse, *that* I may see and tell
Of things invisible to mortal sight.'

MILTON, On his Blindness.

PARSING.

Thus—adv. of manner, qual. 'return.'
but—conj., disj., joining 'seasons return,' and 'day re turns.'
not—adv. of negation, qual. 'returns.'
or—conj., disj., joining 'day returns not' and 'sweet approach returns not.'
or—conj., disj., joining 'sweet approach returns' and 'light, etc., returns.'
divine—adj. of quality, qual. 'face.'
but—conj., disj., joining 'day returns not' and 'clouds return.'
instead—in., prep., showing reln. between 'stead' and 'surround,' and *stead*, abs. noun, neut., sing., 3rd, obj., gov. by 'in.'
ever-during—partl. adj. of quality, qual. 'dark.'
cut—past part. of 'to cut,' refg. to 'me.'
off—adv. of manner, qual. 'cut.'
presented—past part. of 'to present,' refg. to 'me.'
expunged—past part. of 'to expunge,' refg. to 'works.'
quite—adv. of deg., qual. 'out.'
so—adv. of deg., qual. 'much.'
much—adv. of manner, qual. 'shine.'
the—adv. of deg., qual. 'rather.'
rather—adv. of deg., comp. deg., qual. 'shine.'
thou—per. pro., masc., sing., 2nd, nom. to 'shine.'
from—prep., showing reln. between 'thence' and 'purge.'
thence—adv., used as a com. noun, neut., sing., 3rd, obj., gov. by 'from.'
that—cop. conj., joining 'thou purge' and 'I may see.'

ANALYSIS.

Sentence.	Kind of Sentence.	Conn.	Subject.	Predicate.	Object.	Ext. of Pred.
(*a*) So much the rather thou celestial Light shine inward	Princ. S.		Thou celestial Light	shine		inward (place) so much the rather (m'nn'r)
(*b*) and illuminate the mind through all her powers	Princ. S. *co-ord with* (*a*)	and	[thou]	illuminate	the mind	thr'ugh all her powers (place)
(*c*) there plant eyes	Princ. S.		[thou]	plant	eyes	there (place)
(*d*) all mist from thence purge	Princ. S.		[thou]	purge	all mist	from thence (place)
(*e*) and disperse	Princ. S.	and	[thou]	disperse	[all mist]	
(*f*) that I may see	Adv. (reason) to (*e*)	that	I	may see		
(*g*) and tell of things invisible to mortal sight.	Adv. (reason) to (*e*)	and	[I]	may tell	of things invisible to mortal sight (ind. obj.)	

37. ORO should at once seek permission to sit at some college; there is no limit of time fixed by the Code. It is now possible to enter for one year [Art. 118 (*b*)], if you are already certificated. If you enter for two years you will take the First and Second Year's Papers in due course.

38. SCRIBBLER'S style would be good if uniform. It is firm.

39. VERNON.—Parse: 'It took the *Alert* three days to steam twenty miles.'

It—per. pro., neut., sing., 3rd, nom. to 'took.'
took—irreg. intrans. verb, act., ind. past, 3rd, sing., agreeing with 'it.'
Alert—prop. noun, neut., sing., 3rd, obj., gov. by 'for.'
three—def. num. adj., qual. 'days.'
days—abs. noun, neut., plur., 3rd, objective of duration of time, after intrans. verb 'took'; or obj., gov. by 'during,' und.
to steam—verb, reg. intrans., act. inf., gov. by '*Alert*.'
twenty—def. num. adj., qual. 'twenty.'
miles—abs. noun, neut., plur., 3rd, objective of space; or gov. by prep. 'over,' und.

Note.—Different ellipses may be adopted; the one used is, 'It took *during* three days *for* the *Alert* to steam *over* twenty miles.'

You may also say:—'It to steam over twenty miles took three days by the *Alert*.'

The construction is peculiar, owing to the use of the impersonal *it*.

Put it into the passive form, and the meaning is clear:—'Three days were taken by the *Alert* to steam twenty miles.'

40. GENTIL.—The answer is evidently wrong, as the income in both cases is the same. The question is worded very ambiguously.

41. FLANDERS.—Analyse:

'Thou movest—but increasing with the advance,
Like climbing some great Alp, which still doth rise,
Deceived by its gigantic elegance;
Vastness which grows—but grows to harmonise
All musical in its immensities;
Rich marbles—richer painting—shrines where flame
The lamps of gold—and haughty dome which vies
In air with Earth's chief structures, though their frame
Sits on the firm-set ground—and this the clouds must claim.'

Byron's *Childe Harold*, Canto IV.

SENTENCE.	KIND OF SENT.	CONNECTIVE.	SUBJECT.	PREDICATE.	OBJECT.	EXTENSION OF PRED.
(*a*) Thou movest, but increasing with the advance, like climbing some great Alp, deceived by its gigantic elegance	Princ. sent.		Thou—but increasing with the advance, like climbing some great Alp, deceived by its gigantic elegance	movest		
(*b*) which still doth rise	Adj. sent. to Alp in (*a*)	*In rel.*	which	doth rise		still (time)
(*c*) vastness	Princ. sent.		vastness	[is here]		
(*d*) which grows all musical in its immensities	Adj. sent. to (*c*)	*In rel.*	which	grows all musical in its immensities		
(*e*) but which grows to harmonise	Adj. sent. advers. to (*d*)	but	which	grows		to harmonise (purpose)
(*f*) rich marbles	Princ. sent.		Rich marbles	[are here)		
(*g*) richer painting	Princ. sent.		richer painting	[is here]		
(*h*) shrines	Princ. sent.		shrines	[are here]		
(*i*) where shine the lamps of gold	Adj. sent. to (*h*)		the lamps of gold	shine		where (place)
(*j*) and haughty dome	Princ. sent.	and	haughty dome	[is here]		
(*k*) which vies in air with Earth's chief structures	Adj. sent. to (*j*)		which	vies	with Earth's chief structures (ind. obj.)	in air (place)
(*l*) though their frame sits on the firm-set ground	Adv. (cond) to (*k*)	though	their frame	sits		on the firm-set ground (place)
(*m*) and this the clouds must claim	Adv. (cond) to (*k*)	and	the clouds	must claim	this	

42. ST. HELEN'S.—*Fawcett's* 'Political Economy'; National Society's Manual, 'School Management'; *Clyde's* 'Geography.' Writing excellent.

43. ARLWYN DYFED.—Get a Guide to the Civil Service.

44. ROGO.—Whichever style you adopt let it be uniform. Omit the looped letters in every case, if at all. Large hand, poor; small hand has more firmness.

45. AP FORWERTH.—Large hand would reduce your percentage below fifty. You cannot control your pen to secure even strokes. Mr. Winch was subject to the rules of the examination, which allow a pencil, but no ruler.

46. VEGA has not sent any large hand; his current hand lacks character.

47. LEONIDAS *may* gain a scholarship, but not through his superior writing.

48. EDITH will probably lose many marks through carelessness. Like too many P. T.'s she has neglected the study of forms of letters.

49. D. W. M. T. might obtain eighty per cent. or more, if his capitals were in harmony with the rest.

50. ALPHA BETA can write fairly well. Study capitals. Specimen sixty-five per cent.

51. VENUS.—The books named are all good in their way, but cyclopædic works are for general reference, and not for study. The pence spent on them will secure a mine of wealth.

52. LATINUS must judge by the last published questions. No 'book' is prescribed for the Q. S. Ex.

53. SAUVAGE will pass his fourth year's examination in July, but his Agreement, which is not affected by the 'change of date,' binds him to the school until November.

54. A CONSTANT SUBSCRIBER should consult *Bisson's* 'Our Schools and Colleges.' Several scholarships are given by the London and other Board Schools.

55. MAUVAIS ECRIVAIN has adopted the approved round style, and his writing would gain, at least, seventy-five per cent.

56. VIOLET.—We know of no complete summary of the war in the Soudan. Style of writing not good, sixty per cent. at most.

57. ANXIOUS.—Consult your Inspector, or if this is not possible, ask the Department, when you sit for your Certificate, to grant you the marks obtained for reading and teaching before your removal. Your case is not singular.

58. HIBERNIAN.—Your success in a Science Examination must depend upon your industry; its character, on your taste. Todhunter is an acknowledged authority. There is a Civil Service Grammar, but if you have mastered Canon Daniels', you need not fear. There is no periodical exactly answering your description. An English candidate has to receive ten favourable records on his certificate before he enters the first-class. See the English Code of Regulations, 1884.

59. PWLLHELI.—The Board can give such instructions to the attendance officer as it pleases. There is nothing in the Code to prevent the husband of a Head-mistress, if not himself a teacher, from retaining his seat on the Board. No officer of a school-board can be counted on the staff (Art. 81). The question as to the legality of tradesmen supplying materials to the Board of which they are members, would have to be determined on each particular case.

60. A. B. C.—*J. Hogg's* 'The Microscope,' 500 engravings, 7s. 6d., is published by Routledge.

Mensuration.

1. EX-P. T.—How many flagstones, each 5·76 feet long and 4·15 feet wide, are required for paving a cloister which encloses a rectangular court 45·77 yards long and 41·93 yards wide, the cloister being 12·45 feet wide? (*Barnard Smith.*)

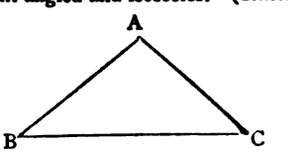
$$\text{Area of cloister} = 2[\{(45{\cdot}77+41{\cdot}93)\times 3+(12{\cdot}45\times 2)\}\times 12{\cdot}45] \text{ sq. ft.}$$
$$= 2[\{(87{\cdot}7\times 3)+24{\cdot}9\}\times 12{\cdot}45] \text{ sq. ft.}$$
$$= 2\{(263{\cdot}1+24{\cdot}9)\times 12{\cdot}45\} \text{ sq. ft.}$$
$$= 2(288\times 12{\cdot}45) \text{ sq. ft.}$$
$$\text{Area of a flagstone} = (5{\cdot}76\times 4{\cdot}15) \text{ sq. ft.}$$
$$\therefore \text{No. of flagstones required} = \frac{\overset{50}{\cancel{288}}\times \overset{3}{\cancel{12{\cdot}45}}\times 2}{\underset{1}{\cancel{5{\cdot}76}}\times \underset{1}{\cancel{4{\cdot}15}}} = \underline{300}. \quad \text{Ans.}$$

2. F. W. F.—A bucket is in the form of a frustrum of a cone; the diameter at the bottom is 1 foot, and at the top 1 foot 3 inches, the depth is 1 foot 6 inches; find to the nearest pound, how much more the bucket weighs when full of water than when empty? (*Todhunter.*)

Volume of frustrum of cone $= \frac{h}{3}(a^2+ab+b^2)$, where h = height, a^2 and b^2 the areas of the two ends;

$$\therefore \text{Volume} = \left(\frac{1\frac{1}{2}}{3}[\{(1\tfrac{1}{4})^2+(1\tfrac{1}{4}\times 1)+1^2\}\times{\cdot}7854]\right) \text{ cub. ft.}$$
$$= [\tfrac{1}{2}\{(\tfrac{25}{16}+\tfrac{5}{4}+1)\times{\cdot}7854\}] \text{ cub. ft.}$$
$$= \left(\frac{1}{\cancel{2}}\times\frac{21}{\cancel{16}}\times\frac{{\cdot}3927}{\cancel{{\cdot}7854}}\right) \text{cub ft.}$$
$$= \frac{23{\cdot}9547}{16} \text{cub. ft.}$$
$$= 1{\cdot}49716875 \text{ cub. ft.};$$
$$\therefore \text{Difference in weight} = (1{\cdot}49716875\times 1000) \text{ oz.}$$
$$= 1497{\cdot}16875 \text{ oz.}$$
$$= 93 \text{ lbs. } 9{\cdot}16875 \text{ oz.}$$
$$= 94 \text{ lbs. to the nearest pound.}$$

3. J. G. J.—Find the area in acres, roods, and poles of a triangular field, whose perimeter is 30 chains 32 links, the triangle being right-angled and isosceles. (*Scholarship*, 1880.)



$BC^2 = AB^2+AC^2$, (I. 47.)
$= 2AB^2$; (the triangle being isosceles).
$\therefore BC = \underline{\sqrt{2}AB}.$

30 chains 32 links = 3032 links;
$AB+AC+BC = 3032$
$AB+AB+\sqrt{2}AB = 3032$
$(2+\sqrt{2})AB = 3032$
$\therefore AB = \underline{\frac{3032}{2+\sqrt{2}}}.$

$$\text{Area of } \triangle ABC = \tfrac{1}{2}(AB\times AC) = \tfrac{1}{2}AB^2 = \tfrac{1}{2}\left(\frac{3032}{2+\sqrt{2}}\right)^2 = \frac{3032\times 1516}{4+4\sqrt{2}+2} = \frac{4596512}{6+4\sqrt{2}} = \frac{2298256}{3+2\sqrt{2}} = \frac{2298256(3-2\sqrt{2})}{(3+2\sqrt{2})(3-2\sqrt{2})} = \frac{2298256(3-\sqrt{8})}{9-8} = 2{,}298{,}256(3-2{\cdot}8284\ldots) = 2{,}298{,}256\times{\cdot}1716 \text{ (nearly)} = \underline{394{,}380{\cdot}7296};$$

$\therefore$ Area of field = 394,380·7296 sq. links
= 3·943807296 ac.
= 3 ac. 3 ro. 31 po.

Algebra.

1. J. COPE.—Find the quotient of $x^2+ax+bx+ab$ and $x^2+ax+cx+ac$, and reduce $\frac{x^{m-1}y^{2n}}{x^{2m}y^{n+1}}$ to its lowest terms.

(1) $\frac{x^2+ax+bx+ab}{x^2+ax+cx+ac} = \frac{(x+a)(x+l)}{(x+a)(x+c)} = \underline{\frac{x+b}{x+c}}.$ Ans.

(2) $\frac{x^{m-1}y^{2n}}{x^{2m}y^{n+1}} = \frac{y^{2n-(n+1)}}{x^{2m-(m-1)}}$ (dividing by $x^{m-1}y^{n+1}$)
$= \frac{y^{2n-n-1}}{x^{2m-m+1}} = \underline{\frac{y^{n-1}}{x^{m+1}}}.$ Ans.

2. CROMWELL.—Factorise,

$$\left(1-\frac{a}{a+b}\right)^6-\left(1+\frac{a}{a+b}\right)^6. \quad (Knight.)$$

$$\left(1-\frac{a}{a+b}\right)^6-\left(1+\frac{a}{a+b}\right)^6$$
$$=\left(\frac{a+b-a}{a+b}\right)^6-\left(\frac{a+b+a}{a+b}\right)^6$$
$$=\left(\frac{b}{a+b}\right)^6-\left(\frac{2a+b}{a+b}\right)^6$$
$$=\frac{b^6-(2a+b)^6}{(a+b)^6}$$

{Now, $x^6-y^6=x^3-y^3=(x+y)(x^2-xy+y^2)(x-y)(x^3+xy+y^2).$}

$$=\frac{(b+2a+b)\{b^2-b(2a+b)+(2a+b)^2\}\{b-(2a+b)\}\{b^2+b(2a+b)+(2a+b)^2\}}{(a+b)^6}$$
$$=\frac{(2a+2b)(b^2-2ab-b^2+4a^2+4ab+b^2)(b-2a-b)}{(a+b)^6}$$
$$=\frac{2(a+b)(4a^2+2ab+b^2)\times-2a(4a^2+6ab+3b^2)}{(a+b)^6}$$
$$=-\frac{2(a+b)}{a+b}\cdot\frac{2a}{a+b}\cdot\frac{4a^2+2ab+b^2}{(a+b)^2}\cdot\frac{4a^2+6ab+3b^2}{(a+b)^2}$$
or, $$-2\cdot\frac{2a}{a+b}\cdot\frac{4a^2+2ab+b^2}{(a+b)^2}\cdot\frac{4a^2+6ab+3b^2}{(a+b)^2}$$

3. J. YOUNG.—The sum of the digits of a certain number is equal to one-fourth of the number itself. If the order of the digits be reversed, the sum of the digits is equal to one-seventh of the number thus obtained. Find the number. (*Pupil Teachers' Course.*)

Let x = Digit in tens' place,
And ,, y = ,, ,, units' ,, ;

Then, (1) $x+y=\frac{10x+y}{4}$
(2) $x+y=\frac{10y+x}{7}$

(1) $4x+4y=10x+y$
$3y=6x$
$\therefore y=2x.$

(2) $7x+7y=10y+x$
$6x=3y$
$\therefore y=2x.$

$\therefore$ Any number which has the units' figure double the tens' figure fulfils the conditions.

$\therefore$ No. = 12, or 24, or 36, or 48.

Note.—Perhaps full percentage of marks.

4. SOLICITOR.—If the $(p+q)^{th}$ term of a geometrical progression be m, and the $(p-q)^{th}$ term be n, show that the p^{th} term is $\sqrt{mn}$.

p^{th} term $=ar^{p-1}$,
$(p+q)^{th}$ term $=ar^{p+q-1}$,
$(p-q)^{th}$ term $=ar^{p-q-1}$;
$\therefore ar^{p+q-1}=m$
$ar^{p-q-1}=n$

Multiplying, $a^2r^{2(p-1)}=mn$

Extracting square root, $ar^{p-1}=\sqrt{mn}$;

But, p^{th} term $=ar^{p-1}$,

$\therefore p^{th}$ term $=\sqrt{mn}$.

5. Find the square root of :—

$1^3+2^3+3^3+4^3+5^3+6^3+7^3+8^3+9^3$.

(*Johnston's* Civil Service Arithmetic.)

The sum of the cubes of any natural numbers is equal to the square of the sum of the numbers.

$\therefore$ Square root $=1+2+3+4+5+6+7+8+9$
$=(1+9)\times\frac{9}{2}$ (Arithmetical Progression)
$=10\times\frac{9}{2}$
$=45$. Ans.

6. PAG.—Solve :—

$$\frac{3abc}{a+b}+\frac{a^2b^2}{(a+b)^3}+\frac{(2a+b)b^2x}{a(a+b)^2}=3cx+\frac{bx}{a}. \quad (Todhunter.)$$

$$\frac{3abc}{a+b}+\frac{a^2b^2}{(a+b)^3}+\frac{(2a+b)b^2x}{a(a+b)^2}=3cx+\frac{bx}{a}$$

Multiplying by $a(a+b)^2$;

$$3a^2bc(a+b)+\frac{a^3b^2}{a+b}+(2a+b)b^2x=3ac(a+b)^2x+b(a+b)^2x$$
$$3a^2bc(a+b)+\frac{a^3b^2}{a+b}=3ac(a+b)^2x+a^2bx+2ab^2x+b^3x-2ab^2x-b^3x$$
$$3a^2bc(a+b)+\frac{a^3b^2}{a+b}=3ac(a+b)^2x+a^2bx$$
$$ax\{3c(a+b)^2+ab\}=a^2b\left\{\frac{3c(a+b)^2+ab}{a+b}\right\}$$
$$\therefore x=\frac{ab}{a+b}.$$

7. LOUIS.—What is the condition that x^2+px+q may be divided by $x-r$?

$$x-r)x^2+px+q(x+(p+r)$$
$$x^2-rx$$
$$(p+r)x+q$$
$$(p+r)x-r(p+r)$$

$\therefore$ Condition is : $q=-r(p+r)$;

$$pr+r^2=-q$$
$$r^2+pr+\left(\frac{p}{2}\right)^2=\frac{p^2}{4}-q$$
$$=\frac{p^2-4q}{4}$$
$$r+\frac{p}{2}=\frac{\pm\sqrt{p^2-4q}}{2}$$
$$\therefore r=\frac{\pm\sqrt{p^2-4q}-p}{2}.$$

$\therefore$ Condition is : $r=\frac{1}{2}(\pm\sqrt{p^2-4q}-p)$.

Note.—There are two exceptions to the rule you give. (1) When two triangles have the three angles of the one respectively equal to the three angles of the other, the two triangles are not necessarily equal, as they may be similar but not equal. (2) When two triangles have two sides of the one equal to two sides of the other, each to each, and an angle opposite to one side of one triangle equal to the angle opposite the equal side of the other triangle, the triangles are not necessarily equal, as in one triangle the angle opposite the other equal side may be *acute*, and in the second triangle it may be *obtuse*.

8. E. COUMBE.—Show that $x^2+axy+y^2+bx+cy$ can be split up into two simple factors, if $abc=b^2+c^2$.

If $abc=b^2+c^2$,
$\therefore a=\frac{b^2+c^2}{bc}$;

Then, $x^2+axy+y^2+bx+cy$
$=x^2+\frac{b^2+c^2}{bc}xy+y^2+bx+cy$
$=x^2+bx+\frac{b^2+c^2}{bc}xy+cy+y^2$
$=x^2+bx+\left(\frac{b}{c}+\frac{c}{b}\right)xy+cy+y^2$
$=\left(x+b+\frac{b}{c}y\right)\left(x+\frac{c}{b}y\right)$.

9. F. HOLTON.—Express x^4-28x^2+16 as the product of two real quadratic factors.

x^4-28x^2+16
$=x^4+8x^2-36x^2+16$
$=x^4+8x^2+16-36x^2$
$=(x^4+8x^2+16)-36x^2$
$=(x^2+4)^2-(6x)^2$
$=(x^2+4+6x)(x^2+4-6x)$
$=(x^2+6x+4)(x^2-6x+4)$.

10. ROGO.—A sum of £23 14s. is to be divided between A, B, and C: if B gets 20 per cent. more than A, and 25 per cent. more than C, how much does each get? (*1st Stage Mathematics*, 1883.)

B's share = A's share + ⅕ of A's share
= ⅚ of A's share;
∴ A's share = ⅘ of B's share.

B's share = C's share + ¼ of C's share
= ⅘ of C's share;
∴ C's share = ⅘ of B's share.

Let x = B's share in pounds;

Then, $x + \frac{5x}{6} + \frac{4x}{5} = 23\frac{7}{10}$

$30x + 25x + 24x = 711$

$79x = 711$

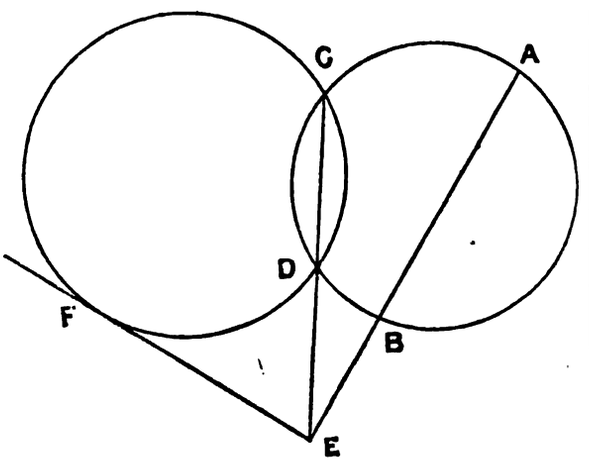
$\therefore x = 9$.

∴ B's share = £9;
A's ,, = ⅘ of £9 = £7 10s.;
C's ,, = ⅘ of £9 = £7 4s.

Geometry.

1. MATRIC.—Describe a circle through two given points, and touching a given circle.

Determine the number of the solutions of the problem, and when it is impossible. (*London Matriculation, June*, 1882.)



Let A, B, be the two given points.

Take any point C on the circumference of the given circle, and describe a circle through A, B, C, (IV. 5.)

If this described circle touch the given circle, it is the circle required.

But if not, let D be the other point of the intersection of the two circles.

Let AB and CD be produced to meet at E. From E draw a straight line touching the given circle at F.

Then a circle described through A, B, F shall be the circle required,

Proof.—Rectangle AE.EB = Rect. CE.ED, (III. 36, Cor.)
But, Rect. CE.ED = EF^2, (III. 36.)
∴ Rect. AE.EB = EF^2; (Ax. 1.)

Hence the circle described through A and B to touch the given circle at F will be the required circle, (III. 37.)

There are two solutions, because two straight lines can be drawn from E to touch the given circle.

If the straight line which bisects AB at right angles, passes through the centre of the given circle, the construction fails, for AB and CD are parallel. In this case F must be determined by drawing a straight line parallel to AB so as to touch the given circle.

It is always possible to draw a circle through two given points to touch a given circle.

Friedrich Fröbel.

BY HIS PUPIL, HEINRICH HOFFMAN.

X.—(*continued.*)

'HOWEVER different the pupils may be in social circumstances, no distinction is made, either in their apparel or in the form of address; all associate freely and pleasantly, as if simply obeying their own laws, like brothers; and, whilst each employs his own powers, and plays his own part in apparent independence in the common games, all are under the constant supervision of their masters, who move among them, and join in their games, not as their superiors, but as their equals. Thus no latent power remains unnoticed; in so large a family circle it finds the stimulus it requires, as well as the proper place for its exercise; every commendable tendency meets with the sympathy it needs. On the other hand, improper conduct finds no soil in which to thrive. He who is bent on mischief soon finds himself the loser. The many can easily do without him; he is excluded, isolated, and naturally growing anxious to be re-admitted, finds it best to amend his ways. Thus the boys unwittingly rebuke, punish, and educate one another by manifold encouragement and by mutual restriction. Moreover, the favourable impression one gets of the whole is remarkably strengthened by the admirable spirit of order manifested throughout, not only with respect to the regularity—as of clockwork—with which all the details of the establishment are conducted, but also with respect to the scrupulous cleanliness everywhere apparent, which, I must confess, is, to such an extent, a rare ornament in public institutions.

'In teaching, their first law is self-activity of the mind. So the young mind is not made a savings-box, where coins of all sorts and coinage are hoarded up, just as they are current in the trade; but the teaching proceeds slowly, steadily, step by step, always in accordance with the natural laws of the human mind, from the simple to the compound, from the concrete to the abstract, always so nicely adapted to the child's inner wants that he turns just as joyfully to his studies as to his games.

'My arrival and official duties having caused an interruption of the usual routine of lessons, I was much amused by some of the children who, with sobs and tears, asked the head-master whether they were to play all day, and so miss their school work, and whether only the big ones were to enjoy their lessons.

'My impression of the institution coincides with that of all unprejudiced visitors, who have investigated it. None have left it without satisfaction. Many, whose intelligence I consider of the highest order, speak with enthusiasm and admiration of the high aims pursued, and of the perfectly natural means taken to secure them as unfailingly and as comprehensively as possible.

'The chief aim of the institution is by no means knowledge and science, but the unfettered, self-active culture of the mind; not outward knowledge, which, merely serving as an ornament, neither enlightens nor strengthens the mind, and which can never give pleasure to the child, since only the consciousness of steady progress can make him truly happy. Mere science would be little thought of in Keilhau, if a means more universal still could be found to rouse and strengthen the mind, and to lead the child to his high destination.

'What these children know is no disorderly mass of facts, but their knowledge has life and substance, and, where possible, is at once put to practical use; it does not consist of meaningless words; everything must have undergone the test of the mind.

'The institution is indeed a gymnasium in the proper meaning of the word; for all the doings here are true gymnastics to the mind. Happy the children who, from their sixth year, are trained here! If all our schools could thus be remodelled, we should, in a few generations, become a nation, more noble, more powerful, and more pious. So much is this my earnest conviction, that I congratulate my native country on the possession of an establishment than which, even now in its present juvenile state, none better is to be found among the best and most renowned far and near, and for the fame of which, in less than five years, the boundaries of Germany will be too narrow.'

This remarkable report, of which we have given some extracts only, was first published in the 'Isis,' by Oken, Part vii., 1825,. and may be found in full in 'Aus Fröbel's Leben und erstem Streben Autobiographie und kleinere Schriften,' von Dr. Wichard Lange, Berlin, Enslin, 1862. Victory certainly was on the side of Keilhau, but in order not to hurt the feelings of the Prussian Government too much, and considering the nervous pusillanimity of the German Confederation, who were terrified by the sight of long hair, the Rudolstadt authorities decreed that the hair of the boys should be reduced to a less ominous length, and the suspicious-looking coats discarded.

However, although the enemies were silenced, they were by no means subdued. The tree that could not be cut down might with better success be sapped. Financial difficulties alone would not probably affect an institution that enjoyed so much esteem and public confidence so seriously as to imperil its existence. Secretly to undermine this confidence was now the fiendish plan of the Irreconcilables. Malicious calumnies, assisted by the apparent animosity of the Prussian Government, induced many parents of the higher classes to recall their sons, and when once the panic began, more and more were withdrawn, until the number of pupils was in a short time reduced from sixty to five!

In 1823 a nephew of Middendorff's, a student of theology, had come from Halle to visit his uncle. So profoundly was he struck by the spirit of the Institution, that he resolved to join the friends. This he did five years later, at a most opportune time, when such a man was most needed. Of the most honourable character, and with a clear, practical head, this man now took his place at the helm, and the good ship, under his command, easily braved the storm. After the death of Fröbel, he became the proprietor and the head of Keilhau, and by faithful and indefatigable labours in Fröbel's cause, won high commendation. He married the second daughter of Christian Fröbel. To Barop's skilful management the Institution principally owes its safety amidst very great difficulties. The principal sources were all but dried up; and the literary productions, which might and ought to have been handsome tributaries, proved rather a dead weight and an additional cause of anxiety. During the years 1820 to 1826, Fröbel wrote the following publications:—

1. An unser Deutsches Volk. (To the German People.) 1820.
2. Grundsätze, Zweck, und inneres Leben der allgemeinen deutschen Erziehungs-Anstalt in Keilhau. (Principles, Aims and Inner Life of the Nat. Instit. of Keilhau.) 1821.
3. Aphorismen.
4. Ueber deutsche Erziehung überhaupt und über das allgemeine Deutsche der Erziehungs-Anstalt in K. insbesondre. (On German Educ. in general, and on the German Character of the Nat. Inst. of Keilhau in particular.) 1822.
5. Die allgemeine deutsche Erziehungs-Anstalt in Keilhau betreffend. (Concerning the Nat. Inst. in Keilhau.) 1822.
6. Fortgesetzte Nachrichten über die Erz.-A. in K. (Further Accounts of the Nat. Inst. in Keilhau.) 1823.
7. Die Feier des Chrisfestes in der Erziehungs-Anstalt in K. Den verehrten Eltern der Zöglinge, den Freunden und Gliedern der Anstalt als Festgabe, 1824. (The celebration of Christmas in the Nat. Inst. of Keilhau. A Christmas gift to the respected parents of the pupils and to the friends and members of the Inst., 1824.)
8. *Die Menschenerziehung, die Erziehungs-Unterrichts, und Lehrkunst, angestrebt in der allgemeinen Erziehungsanstalt zu K., dargestellt von dem Stifter, Begründer una Vorsteher derselben, Friedr. Fröbel.* (The Education of Man, the art of training and teaching aimed at in the General Nat. Inst. at K., elucidated by the originator and leader, Fried. Fröbel.) 1826.
9. Die erziehenden Familien. Eine Wochenschrift. 1826. (The educating of Families. A weekly publication. 1826.)
10. Durchgreifende, dem deutschen Character erschöpfend genügende Erziehung ist das Grund. und Quellbedürfrist des Deutschen Volkes. Erfurt, 1821. (The primary and principal requirement of the Germans is Education, as thorough, as comprehensive. Erfurt, 1821.)

These writings ought to have secured a handsome, if not a large income—at all events, enough to keep the Institution unburdened. But publishers were difficult to find, and Fröbel, over timid, though an excellent arithmetician on paper, was but a poor hand at practical business, and expected a mine of gold from their publication, if he took the entire business in his own hands. Disappointment and increased debts were the results. The books failed to serve their purpose, as the public learned but little of their existence. The dignified attitude which self-respect demanded forbade, of course, all noisy trumpeting and puffing. The managers of the institution justly considered that the value of their work could be seen without placards: but they failed to find the golden mean, where modesty and practical management combine to secure success.

(To be continued.)

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Recent Inspection Questions.

[*The Editor respectfully solicits contributions—all of which will be regarded as* STRICTLY PRIVATE—*to this column. For obvious reasons, it cannot be stated in which district the questions have been set.*]

Arithmetic.

STANDARD I.—DICTATED.

(1)	(2)	(3)	(4)
86	68	760	670
704	407	146	164
975	597		
13	14	614	506
364	643		
2142	1729		

STANDARD II.—DICTATED.

(1)	(2)
76,041	94,520
18,260	759
57,781	71,740,680

(3)	(4)
9)48,025	11)90,617
5336+1	8237+10

STANDARD III.

(1) What is the difference between £37 18s. 9¾d. and £225? Ans. £187 1s. 2¼d.

(2) How much had I left out of a sovereign after spending a florin, half-crown, sixpence and three farthings? Ans. 14s. 11¼d.

(3) There were 807 men in a ship. Each man has a pound of biscuits a day. How many pounds of biscuits would they require for 570 days?

Ans. 459,990.

STANDARD IV.

(1) How many inches are there in 5 miles?

Ans. 316,800.

(2) What is the value of 110 lbs. of coffee at 1s. 10d. per lb.? Ans. £10 1s. 8d.

(3) How many sheets can be made from 9 pieces of Irish linen, each piece being 30 yds. long, allowing each sheet to contain 3 breadths of linen and to be 3 yds. in length? Ans. 30.

STANDARD V.

(1) Find the value of 676 things at £7 18s. 10½d. each. Ans. £5369 19s. 6d.

(2) $\frac{1}{2}+\frac{7}{8}+\frac{1}{8}+\frac{2}{5}$. Ans. $1\frac{1}{1}\frac{3}{2}\frac{3}{0}$.

(3) Find the cost of 6 cases, each weighing 17 cwt. 2 qrs. at £1 14s. 7½d. per ton.

Ans. £9 1s. $9\frac{2}{5}$d.

STANDARD VI.

(1) How many years will it take for £340 12s. 6d. to amount to £367 17s. 6d. at 4 per cent per annum?

Ans. 2 years.

(2) A grocer bought 2 tons 3 cwt. 3 qrs. of sugar for £120, and paid for carriage £2 5s. 3½d.; how much per cwt. must he sell it at so as to gain a clear profit of £61 10s.? Ans. £4 4s. $0\frac{2}{7}\frac{3}{5}$d.

(3) Add $5\frac{2}{3}$ guineas, $\frac{3}{8}$ shilling, $\frac{2}{3}$ of 7s. 6d. Take from it £$2\frac{1}{5}$, and bring result to fraction of $4\frac{1}{2}$ guineas.

Ans. $\frac{6}{7}\frac{5}{6}\frac{1}{3}$.

(4) A man pays an income-tax of 7d. in the £, and he has still left £249 19s. 9½d.; what was his whole income? Ans. £257 10s.

Grammar.

STANDARD IV.

(1) Parse:—'The rich man's house stands high and dry.'

(2) Parse words in italics in:—'And *Ardennes waves above them her* green *leaves dewy* with *Nature's* tear-drops.'

STANDARD V.

(1) Parse and analyse:—'Lumps of sugar were given to the bird, which he ate.'

(2) Analyse and parse the words in italics:—'*And* Ardennes waves above them her green leaves dewy with *Nature's* tear-drops.'

(3) What is the use of '*and*' in the above sentence?

(4) Form an adjective from *Nature*.

STANDARDS VI. AND VII.

(1) Parse and analyse:—

(*a*) Mary is the daughter of a rich merchant who lives near Manchester.

(*b*) Tell me what they saw in the park.

(2) What are the meanings of the following prefixes, and give examples of their use?—

(*a*) ad, ante, post, sine, ex.

(*b*) contra, de, pro, inter, pre, extra.

Composition.

Write a letter on a *Concert* or a *Policeman*.

STANDARD VII.

(1) Give the meaning and examples of the following prefixes:—

(*a*) amphi, dia.

(*b*) epi, hyper.

(2) Give the meaning, with examples, of the following affixes:—

(*a*) -less, -ful, -let, -kin, -er, -ship.

(*b*) -ish, -fy, -ling, -ock, -or, -ness.

—o—

UNIVERSITY OF LONDON.—The following are the names of the Examiners for 1884-85, in those subjects of the curriculum which are most widely taken up:—

Classics.—Leonhard Schmitz, Esq., LL.D., Ph.D., F.R.S.E., and Prof. A. S. Wilkins, LL.D., M.A.

The English Language, Literature, and History.—Henry Craik, Esq., M.A., and Prof. J. W. Hales, M.A.

The French Language and Literature.—Rev. P. H. E. Brette, B.D., B.A., and B. P. Buisson, Esq., M.A.

The German Language and Literature.—Prof. F. Althaus, Ph.D., and Rev. C. Schoell, Ph.D.

The Hebrew Text of the Old Testament, the Greek Text of the New Testament, the Evidences of the Christian Religion, and Scripture History.—R. L. Bensly, Esq., M.A., and Rev. Prof. Leathes, D.D., M.A.

Mental and Moral Science.—Prof. G. Croom Robertson, M.A., and James Ward, Esq., M.A.

Political Economy.—J. N. Keynes, Esq., M.A., B.Sc., and Prof. Bonamy Price, LL.D., M.A.

Mathematics and Natural Philosophy.—Prof. A. G. Greenhill, M.A., and Benjamin Williamson, Esq., M.A., F.R.S.

Experimental Philosophy.—Prof. G. Carey Foster, B.A., F.R.S., and Prof. A. W. Reinold, M.A., F.R.S.

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The Practical Teacher.

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The numbers of the *Practical Teacher* for February and March, 1884, are now out of print.

How to Teach Botany.

BY J. W. WREN,

Head-Master of the Board School, Duke Street, Deptford.

HAVING for some years past successfully taught elementary botany in National and Board schools, I have been asked to give an outline of my plan of teaching it. It is thought that my experience may be a guide to those readers of the PRACTICAL TEACHER who are thinking of taking it as a specific subject. Instruction in botany has for some years been recognised as appropriate to our elementary schools. Until within the past few years, however, it has not been generally taught as a specific subject. Many teachers have looked upon it as 'hard,' while others have doubted its value as an educational weapon. Experience, however, shows it to be a most valuable educational aid in the hands of a teacher who has a love for the subject. It calls forth and trains the thinking powers and develops the faculty of observation. It accustoms children to compare and discriminate, and enforces accuracy of expression. It is an exact science and may be made a most valuable means of mental training. Each lesson should be illustrated by chalk drawings, printed diagrams, and, as frequently as possible, by specimens of living plants. *Each pupil should handle a specimen and dissect it as directed by the teacher.* Simple descriptions of the parts under consideration should be written on the blackboard, and at the close of each lesson the pupils should be required to reproduce these notes. Questions bearing on the lessons should be given out occasionally to be answered on paper, and afterwards corrected by the teacher.

STAGE I.

At this stage the pupil has to learn the *characters* of the root, stem, leaves, and parts of a flower—the lessons to be illustrated by specimens of common flowering plants, the framers of the syllabus rightly deeming it useless for a child to study botany unless this indispensable provision is made for the acquisition of those habits of observation which render natural history so peculiarly useful as a branch of mental training. We encourage our scholars to gather specimens, and in this way we have made quite a collection of specimens of the flora of the neighbourhood, all dried and suitably mounted and named. The London School Board gives direct encouragement to this branch of teaching by supplying a handsome museum cupboard, wherein we may store all apparatus used in science teaching.

THE ROOT.—Teacher and scholars being provided with a specimen of some plant common in the neighbourhood, say a grass, the teacher will direct their attention to the principal parts of the plant, viz., the root, stem, leaves, flowers, etc. It will be easy for him to elicit that the root is the part that grows down into the ground, and this will suggest the question *why* it should do so. He will point out that an uprooted plant quickly dies, because it can no longer absorb nourishment from the soil. Having near him a growing specimen of some such plant as a bean, mustard, or pea, in which the little *root-hairs* are plentifully distributed on the surface of the root, he will point out the means by which the nourishment is taken into the root. In pulling up their specimens the scholars will have noticed that they had to employ a considerable amount of force to get the plant out of the ground, and will thus readily see that the root helps to fix the plant firmly in the ground.

The teacher will now write on the blackboard the facts that have been successively brought under notice, and require the pupils to copy his remarks in their note-books, thus:—

(*a*) The principal parts of a perfect plant are the root, stem, leaves, flowers, and fruit.

(*b*) The root is the part of the plant which grows down into the ground; it serves to hold the plant firmly there, and also absorbs food from the soil for the support of the plant. The food is taken in by the root-hairs.

It will be found that this will cover quite enough ground for a first lesson. The note-book should be used exclusively for botanical notes. In this way the scholar compiles quite a little text-book, which is especially useful for reference in class when the teacher wishes to recapitulate.

The scholars should always be told the subject to be taken up in the next lesson, and encouraged to bring specimens for illustration. In the second lesson on the root it would be best to teach the names given to the various forms the root assumes. The scholars should be invited to bring specimens of the roots of grasses, carrot, dahlia, turnip, etc. Although some of the technical terms appear hard for children to learn, experience shows that they readily pick them up if they are properly introduced to them. A written description of each of the more common forms of root should be entered in the note-books at the time of handling the specimens. The wording of these descriptions should be exact and concise, but as far as possible in the words of the children themselves. Thus when the root of the grass-plant was under examination the teacher would elicit that it was made up of a number of rootlets—that these rootlets were formed of independent *fibres*—that these fibres branch out from one point. Putting these facts together he would write upon the blackboard—

Fibrous roots consist of a number of rootlets, formed of independent fibres branching out from one point, as in grasses. While his pupils are copying the definition into their note-books, the teacher will be making a sketch of a fibrous root upon the blackboard, and will require the class to copy it in the margin of their note-books by the side of the definition. After having, in this way, learnt the names, and become familiar with the more common forms of roots, the teacher would classify them into *useful* and *poisonous* roots. The children would readily give him a list of the names of such useful roots as the carrot, parsnip, turnip, radish, and beet, while he could add to their stock such as the chicory, liquorice, ipecacuanha, madder, tapioca, etc., giving at the same time a short description, method of preparation, etc., of each.

UNDERGROUND STEMS.—Passing from the root, it is well to take up next the underground stems. Some of these being popularly called roots, the teacher would at once point out the difference between a root and an underground stem. The scholars will have noticed that none of the roots they have handled in class have had any signs of leaf-buds upon them. Furnished with specimens of such underground stems as the iris, raspberry, bindweed, couch-grass, etc., the scholars will readily see how these underground stems give off leaf-buds from the upper-side, and rootlets from the under-side, and therefore differ essentially from roots. The names of all the common forms of underground stem would be taught in the same way as the various root forms.

In teaching the names of the useful underground stems, such as arrowroot, garlic, leek, potato, squill, etc., the teacher has ample opportunities of introducing to his class a large amount of useful information upon topics of the most varied kind. For example, when pointing out that the potato instead of being, as it is popularly called, a root, is simply a thickening of an underground stem, he could tell the story of its introduction to this country, and thus in this way add a mite to their knowledge of English history. He could, by washing and grating a little of the tissue of the potato, separate the starch. He would show how dextrine is prepared from this starch, and would further point out, that this dextrine is used largely in calico printing, and in the manufacture of British gum, used to attach postage-labels.

THE STEM.—The lessons on the stem may be made wonderfully interesting and instructive. From their own observation, the pupils will readily see why the stem is called the *ascending* axis. They will notice the fact that there are knots on the stem where the leaves are given off. Hence the points on the stem from which the leaves spring are called knots or nodes, and the spaces between the nodes will therefore be the internodes.

The teacher will have anticipated his lesson, and will have a few beans and grains of wheat germinating —will point out the two seed-leaves in one case, and the one seed-leaf in the other, and will so introduce the terms dicotyledon and monocotyledon, the names by which the two great classes of flowering plants are known. Having some good cross-sections of wood, he will point out that the dicotyledonous trees have stems with a separable bark; medullary rays proceed from the pith in the centre to the circumference. The wood is arranged in concentric circles, the last layer being deposited next the bark. The stems are, therefore, enlarged outwards, as it were; hence the term 'exogens.'

The specimens under examination will show a great difference in the structure of the stems of monocotyledonous trees. The children will be unable to remove the bark; they will fail to discover concentric circles of wood, medullary rays, and a central pith. The teacher will point out that the hardest part of the stem is at the outside, the stem growing thicker for a time by new woody matter being thrust irregularly amongst the older tissue. Stems growing in this way were called by the older botanists 'endogens,' or inward growers. The children will now be able to enumerate, so far as the stem is concerned, the distinctive characteristics of the two great classes of flowering plants. The teacher will have mentioned incidentally that all our British timber-trees, most of our fruit-trees, and the majority of our flowering plants, are exogens, while all kinds of grasses, rushes, sedges, and such flowering plants as orchis, bluebell, crocus, and snowdrop, are endogens; so that the scholars will readily see the value of the exogens as timber-producers, while the wood of the endogens is of small value as timber. In treating of the uses of the stem, the teacher has again an opportunity of imparting a vast amount of useful information. Thus, in speaking of the bark, he will notice the methods of preparing bast, cork, cinnamon, jute, Peruvian bark, etc. The exudations from various stems, such as copal, gamboge, gums, gutta percha, india-rubber, manna, pitch, sugar, tar, turpentine, etc., will also furnish matter for several interesting and instructive lessons.

Having now learnt something of the principal facts concerning the axis of a plant, the scholars will be prepared to study the appendages to the axis, the more important of which are the hairs and prickles, leaves and branches, bracts and flowers. Each and all of these can be studied from specimens, so that the lessons may be made in the highest degree interesting and instructive. The pupils should be encouraged towards the close of the course to

collect specimens of perfect plants, and explain from them the various forms of inflorescence, the different modes of leaf-attachment, referring the leaves, etc., to their respective types.

STAGE II.

The second stage, as laid down in the Educational Code, arranges for the study of the structure of wood, bark, and pith, cells and vessels, together with the food of plants, and the manner in which they grow. The functions of the root, leaves, and different parts of a flower are also to be made the subjects of careful study. The subjects of study as here laid down are not by any means so easy to teach as those laid down in Stage I. The first stage having reference only to the external forms of plants, it is easy for the scholars to see, handle, and verify for themselves all that is brought under their notice. Here, however, we have to deal in part with the microscopic structure of plants, so that the teacher has to rely more upon the use of diagrams. If, however, a lasting impression is to be made on the pupils' mind they must see for themselves specimens of minute structural botany under a good compound microscope. Sections of some soft herbaceous plants are easily prepared for examination, and in this way the various forms assumed by cells and vessels may be brought under the notice of the pupils. The teacher would make sketches of what is seen under the microscope, and the pupils being required to copy them, they would in this way gain a very accurate knowledge of the various forms assumed by cellular and vascular tissue.

Descriptions of the various contents of cells will next form the subject of several highly interesting and instructive lessons. The various sections of wood used in illustrating the lessons on the stem in the first course would here be utilised to show the variations in structure of wood, bark, and pith.

In teaching the manner in which plants obtain their food, it is best to demonstrate at first that liquids can pass through the walls of cells by imbibition. Place a cell of a yeast plant in a dense liquid, and it will be noticed that it becomes more or less collapsed because the contents of the cell pass outwards: while it becomes distended if placed in a thin liquid, owing to the passage of the thinner liquid into the cell. The method of introduction of food substances into the plant may be further illustrated as follows; a small glass tube containing syrup, and having the end covered by a thin piece of membrane, is placed in a glass of water. It is then readily seen that the fluid in the tube rises owing to the passage of the water in the glass through the membrane. By tasting the water in the glass it will be apparent that there has been an interchange between the two liquids although the thinner has flowed the faster. Applying this process to the root, the teacher would point out that within the cells there is the sap, outside there is the water with various mineral salts in solution. Here, then, the scholar would readily recognise that the same conditions obtain as in the simple experiment described above:—there being two liquids of different densities, separated by a permeable membrane—the cell-wall; as a consequence, osmosis ensues, some of the external water passing into the cell and some of the sap being excreted into the soil. The way in which the flow of water into the cells of the roots is maintained, together with the reasons for the rise of the sap from the roots to the leaves, would be explained here. The teacher would also point out that the food materials are not taken up indiscriminately, but that there is what is called selective power. A crop of peas or beans would remove especially salts of lime; potatoes and turnips compounds of potash, and so on. The scholars would thus be brought to see that the same plants grown year after year in the same soil gradually impoverish the ground, whilst food materials needful for other plants would accumulate. Hence the necessity for what is called the rotation of crops. It would be pointed out that the removal of plant food from the soil for the growth of successive crops would ultimately exhaust the soil, were it not that various manures are employed to supply the place of the different materials removed from the soil. Having pointed out that sap passes out by osmosis into the soil, the teacher would show that this is most important to the well-being of the plant. The sap has an acid reaction (that is, it turns vegetable matters blue, litmus red), so that it dissolves many substances in the ground which are very needful for the food of the plant. That this is so may be easily demonstrated. Cover a piece of perfectly smooth marble with soil to the depth of about a quarter of an inch. Place it in a position favourable for germination, and sow upon the soil some seeds of mustard and cress. After allowing the young plants to grow for some time, if the whole be cleaned off, it will be found that the rootlets have eaten their way into the marble, dissolving up the substance and forming minute grooves. This would explain to the scholars why we may sometimes see large trees with their roots sunk into the solid rock.

(To be continued.)

Publications Reviewed.

Outlines of Psychology, with Reference to the Theory of Education. By James Sully, M.A., etc. London: Longmans and Co.

Students of psychology will welcome this new work by Professor Sully. For years past they have had to study the latest contributions to the science in detached essays and reviews. They can now gather the opinion of Professor Sully upon many recent discussions and investigations, copious references to which are given in the book. But this volume gives as much as yet exists of the theory of education, and for the teacher it is the most important work on psychology in the English language.

Are our teachers then to become psychologists? it will be asked; and we may reply at once, yes—at least to the extent that brewers and farmers must become chemists. Of course, it will be said that there have been excellent teachers who never studied the laws of mental phenomena, and not a few are ready to boast that their success is entirely due to their own observation and experience. Let us remember that knowledge is power; a man who is acquainted with the necessary conditions of successfully carrying on his work can attain his ends the more easily, surely, and expeditiously. Some teachers will produce good results without such preparation, but with it they would have produced better results, and often with less labour. As Professor Ward has put it: 'When you fail we could often tell you why you fail, and when you succeed, to a knowledge of the fact we could often add the more valuable knowledge of the reason. We can give you some insight into the laws of the human mind, and the laws of mental growth; we can help you to replace your traditional rules-of-thumb and empirical generalisations by systematic precepts, scientifically deduced.'

Professor Sully has rendered an invaluable service to teachers by pointing out some of the scientific principles involved in their work, and in doing so he has honoured and magnified their calling. But the theory of education is not yet complete, far from it. To enlarge and perfect it should be the pride and ambition of teachers, as well as philosophers; and no one has such opportunities as the teacher to observe, tabulate, and classify the phenomena of mental growth and development.

We recommend our readers to get the book at once, and study it. The style is delightfully clear. The arrangement and printing are perfect.

Arrian's Anabasis of Alexander, literally translated. By E. J. Chinnock, M.A., LL.B. London: Hodder and Stoughton.

When Mr. Chinnock says that 'his theory of the duties of a translator is to give the *ipsissima verba* of his author as nearly as possible,' he goes near talking pure nonsense: if he had been more alive to the truth that it is rarely possible for a translator to convey to his readers those ideas which his author conveyed to *his* readers except by paraphrase, his book would have escaped many such blemishes as these :—

'He had already previously despatched Craterus' (p. 175).

'He thought it expedient that each of them individually should stir up his own men separately' (p. 158).

On the whole Mr. Chinnock's literary style is not much above that of which a good upper-form boy is capable in his *viva-voce* translations. To say that his book is dull reading would be to visit on the head of the translator the fault of his author: but Mr. Chinnock at least has not succeeded in vindicating Arrian from the charge of having achieved an unreadably tame narrative of a most adventurous and inspiring career. There are faults of scholarship in Mr. Chinnock's translation occasionally: *e.g.*, in II. 3, τὸν δεσμὸν τοῦ ξύγου τῆς ἁμάξης does not mean the cord which bound the yoke to the wagon, but the cord of the wagon-yoke, *i.e.*, the cord which bound the yoke to the pole. Nor in the same chapter does ἐμυθέετο mean that a *report* was current, but a *tradition;* and to translate λελύσθαι by 'untied' is to make Alexander guilty of a palpably absurd operation—of which he was not guilty. Criticism of this kind, however, is not inconsistent with the praise which the translator deserves for the conscientious and unfailing industry with which he has done his task. The book is of even merit throughout, and stands on a very different level from most professedly literal translations: though it does not reach a high standard of literary or scholastic elegance, it is of a sound and honest mediocrity in both respects; and might be of much use to beginners in Greek, who, for their sins, are suckled on Arrian.

Introduction to Chemical Analysis. By Alfred Barker, M.A. London: Simpkin, Marshall and Co.

Mr. Barker is head-master of the Grammar School, Keighley, and M.A. of London University. The branches in which a London graduate can take that high degree are classics, mathematics, and moral philosophy. None of these subjects seems specially in accord with chemistry, least of all moral philosophy, the branch in which Mr. Barker has distinguished himself. Nevertheless, the Keighley head-master has here produced a small manual on chemical analysis that meets the two requisites for scientific booklets—it is accurate and intelligible. Intended especially for the use of students preparing for the elementary stage of the South Kensington Examination in Practical Inorganic Chemistry, and especially for that large class of scholars who have not the time or the ability to extract from more standard works on chemistry the special details required for their special work, the Introduction will be found useful by all beginners. It will have this merit, rare in elementary books, of providing nothing that will have to be unlearned. Mr. Barker makes an excellent, and not over use, of the signs of division and sub-division. Letters and numbers are utilised, but not done to death. Especial commendation must be given to him for his persistent use of equations; though the commendations cannot be unreserved, as in one or two cases, notably on page 6, some of the most important reactions are not represented in condensed form. Moreover, he nowhere removes the difficulty of the young student in grasping the meaning of—'precipitates soluble in' this or that particular reagent. Every introductory treatise on practical chemistry should make clear to the reader the fact that these re-solutions are not dependent upon chemical changes, and cannot therefore be represented by chemical symbols.

Personally, also, we object to that naming of compounds which gives the basylous radicle in the form of an adjective. Lead acetate, or platinum chloride, is to us better nomenclature than plumbic acetate, platinic chloride. The only advantage of the adjectival form appears to us to lie in the possibility of distinguishing by its aid between such cases as mercurous and mercuric Salts. This advantage appears to be more than neutralised by the misleading use of the adjective with its sense of qualification, and by such unæsthetic forms as Zincic. On the whole, Mr. Barker's 'Introduction to Chemical Analysis' is an unpretentious work, that attains all the ends at which it aims.

Luther Miller's Ambition. By Lillie Montfort. London: Wesleyan-Methodist Sunday-School Union.

This simple and pleasingly-written little story is well suited for a Sunday-school prize. Luther Miller was a poor lad, who fortuitously made a friend of a well-to-do business man—a Wesleyan, and a Blue-Ribbonite. Taken into this gentleman's warehouse, Luther soon had opportunities of showing himself a valuable servant, and approving himself to all who were over him, by his readiness to work, his bright, cheerful ways, and his care of his master's property. Through all this, his chiefs in the office had fears for Luther. 'He is high-principled, and he loves reading good books, especially the Bible,' they admitted; but they were 'not satisfied that the great necessary change of heart had taken place.' Luther's Sunday-school teacher—not being a Wesleyan, apparently—was somewhat obstructive, for he told the young fellow: 'Some people think they have it (*i.e.*, a new heart); but nobody can be *quite sure*, though we may all try to live up to the Bible.' This 'inefficient teaching' the author thinks very sad, and converts the Sunday-school teacher from such a state of mind. 'Luther's teacher found that the new birth was a real experience, and could only rejoice to describe his change as one "from darkness to light, from the power of Satan unto God."' We think it right to draw attention to this doctrinal teaching, in order that none of our readers may be misled; but the majority of young readers, if not brought up as Wesleyans, would not be greatly affected by this passage, and, of course, the tale is specially written for Sunday-schools of the Methodist denomination. The moral teaching and the high tone of the story are unexceptionable, and its interest is well maintained throughout.

Babies: How to Rear Them. By F. A. Fawkes F.R.H.S. Manchester: John Heywood.

Mr. Fawkes has produced a little work containing much sound science, and sensible, practical advice on the important topic of infant management. A young teacher or domestic economy, or an inexperienced mother, may learn much from his pages. Indeed, the instructions upon infant feeding might be usefully studied by many mothers who have brought up portions of their family, but not to be so strong and healthy as they would have been had the science of feeding a child been understood by the parent. Mr. Fawkes is rightly emphatic upon the point that until a child is seven months old its food should be milk alone—mother's milk, if possible; but failing that, properly-diluted cow's milk. The little book is entirely accurate

upon this matter—as, indeed, we expected it would be, when we read in the preface that the proof-sheets had been read both by Dr. B. W. Richardson and Dr. Sedgwick Saunders; and these two or three pages alone are well worth the trifling price of the book. It is a pity that so useful a little work should be marred by a certain affectation on the part of the author. The very title-page displays this unfortunate failing, when it announces that the pamphlet contains 'a few unconventional suggestions to parents.' If a work on any point of well-established science were really unconventional, it would be worthless; and we do Mr. Fawkes's little booklet a service when we say that it faithfully follows the lines laid down by all instructed writers on the same subjects. The same error of taste and judgment is found in innumerable instances; as when the author prescribes fifteen inches *and a quarter* for the height of a nursing-chair, quite forgetting that, though this particular size may suit (to a quarter of an inch) the length of his nurse's legs, yet other nurses will be shorter, or taller, and might prefer chairs of fifteen and a half inches, or even fourteen and three-quarters and an eighth of an inch. Or again, when he says that a brunette should be chosen for a wet-nurse; or again, when he tells us that 'it may be taken as directly contrary to the law of God for a mother to nurse her child after the ninth month.' In this last sentence, not only is it an affected expression to talk about the law of God when what is meant is simply the condition which will most probably result in a favourable future, but, as frequently happens to those who undertake to interpret Divine ordinances, Mr. Fawkes is a great deal more dogmatic and precise than science authorises him to be. It is true that the end of the ninth month should, as a general rule, terminate the maternal nursing; but this is no supernatural command, but simply the natural consequence of the fact that the appearance of a few teeth, and the chemical change which is found to take place in the saliva about that age, indicate that it is time to begin to prepare the baby to bite at something less likely to object to the process than its mamma, and to digest the more solid foods which it is now capable of undertaking. It ought to be distinctly understood, however, that in those exceptional cases where the appearance of the teeth is much delayed, or where the child's stomach rejects farinaceous food at eight or nine months old, the mother's nursing, or the bottle, as the case may be, should be continued for one, or two, or even three months longer.

We have devoted considerable space to this little work, because the subject is one of special interest to many of our lady readers. Those who are compelled by professional circumstances to bring up their babies by hand, will thank us for directing their attention to this useful little volume, which we strongly recommend to their perusal.

Chronological Sketch of English Political History. By Henry Biddulph Bush, B.A. London and Manchester: John Heywood.

Every one who has attempted to make a Historical Date Table must have experienced the difficulty of giving distinction and prominence to certain facts, without at the same time breaking the continuity of his table. For instance, on looking over such a list we see some facts which belong to Church History, and others to Political; some again might be classed as National, and others as relating to Commerce. Now, if all these occur in the same list, confusion is apt to ensue, and if different lists are used the continuity of events is broken, and the pupil thereby loses one of the best aids he has in remembering the dates and attendant circumstances of the various events by localising their position with respect to others. The ordinary plan is to use a variety of types, but in the little manual now under consideration, a departure has been made in this respect; the assistance of colour has been called in, and those facts which relate to Constitutional History gleam forth in red ink, and those affecting the Church and Religion, in blue, while those not coming under these two heads are printed in ordinary black. Except in the utilisation of colour, Mr. Bush's little book differs very little from other manuals on the same subjects, and its contents therefore call for no special remarks. In printing and general 'get up' the book is all that could be desired.

Home-Lesson Books: Book VII. for Standard VII. By Alfonzo Gardiner. London and Manchester: John Heywood.

This book errs only on the side of fulness. Too much work is provided: even the author himself suggests that some of it should be done in school. With this exception, which can be remedied by judicious selection on the part of teachers, the book is all that can be desired as a Home-Lesson Book. In 176 pages are contained lessons in Scripture, Arithmetic, English and Geography, the latter having alternative lessons suitable for the three courses, so that the book can be used in schools where the standards are grouped. The lessons in English include 378 lines from Shakespeare, 59 from Milton, and 198 from Macaulay, which are well chosen, carefully annotated, and very suitable for repetition. By the use of this book, teachers will save time and endless worry in setting the daily work for home preparation.

The Handy Register of Daily Attendances and Fees. London and Edinburgh: T. Nelson & Sons.

As the name implies, this Register is of a convenient size, and is designed to supply at a glance, at any period of the year, all that may be required to be known from it. It is clearly ruled and printed, having spaces for fifty-one names, with thick lines after every third name for assisting the eye. Names are to be written once; pence columns are placed at the beginning of the book for the whole year; while the attendance columns are divided into months, five weeks being given for each month, so as to allow for making weekly, monthly, or quarterly returns, as may be required by any kind of managers at any specified date. The columns headed 'Child's School Book,' and 'Qualified by Attendances,' and 'Fees due by Education Department,' might be omitted. No space is provided for calculating the average attendance of the children in each register; but ample room is provided for notes, corrections, signatures of managers, etc., at the foot of each book. After a teacher has mastered the rather full directions at the beginning of the register, it will be found well suited for the purpose for which it is intended.

Chambers's Reprints of English Classics: (*a*) Milton's Comus. (*b*) Campbell's Select Poems. (*c*) Select Poems of Mrs. Hemans. London and Edinburgh: W. & R. Chambers.

These Reprints will admirably serve for the repetition required in the subject 'English.' The books are enriched with copious notes, narratives of the circumstances under which the poems were written, and in the case of (*b*) and (*c*) with a short life of the author. The origin and meaning of 'Comus' are clearly given, and a page of examination questions, which we should be glad to see extended, is added. They are got up with all the care and neatness which characterises these publishers.

Genealogy of the Kings of England. A wall-sheet, mounted and varnished. Newcastle-on-Tyne: R. J. Porteus and Co. (Limited).

This is a large and effective chart—about 54 inches by 40—well adapted for school requirements. The names of the reigning monarchs are printed in red, so that the learner can see at a glance the 'turns and twists'—often so puzzling to the beginner in history—in dynastic succession. Though the chart is perhaps quite ample enough for ordinary school-work it is rather a pity that space was not found to include some of those personages who, though

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A History of England and Wales from the Roman to the Norman Conquest. By T. Morgan Owen, M.A. London: George Philip and Son.

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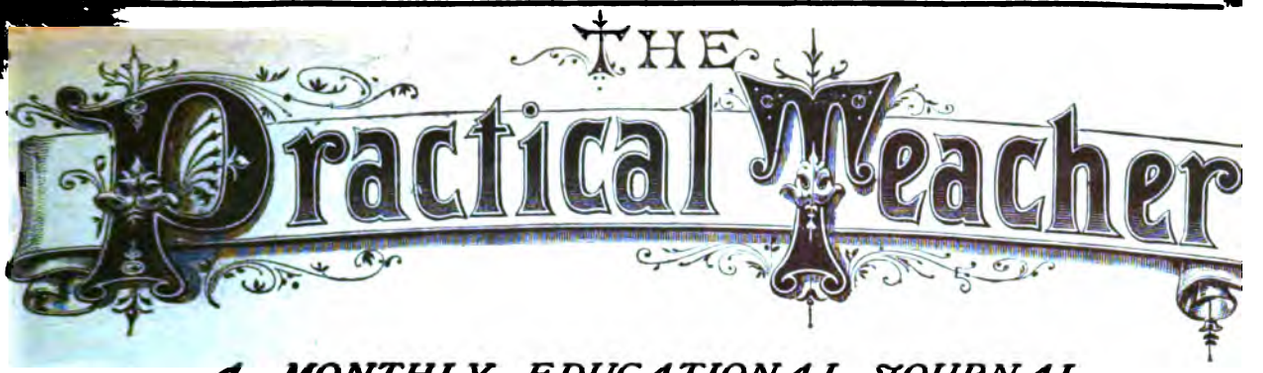

A MONTHLY EDUCATIONAL JOURNAL.

EDITED BY JOSEPH HUGHES.

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Wisdom is humble that he knows no more.'—COWPER.

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VOL. IV. No. 5. JULY, 1884.

Hygiene.

BY ALFRED CARPENTER, M.D., M.R.C.P. (LOND.),

Chairman of the Council of the Sanitary Institute.

WATER—(*Continued*).

Metals.—The next point of importance is to detect the presence of the poisonous metals. These are lead and copper. Some chemists prepare standard solutions, containing a minute proportion of each, one milligramme of a copper salt, being dissolved in one cubic centimetre of distilled water, and then comparing the behaviour of the suspected with the standard solution. Iron may be detected in the same way. The addition of solution of sulphide of ammonium dropped very carefully into a sample of the water contained in a dish of white porcelain, gives a dark colour. It should be well stirred and then compared with the standard solution. A standard lead solution requires 1·66 grammes of acetate of lead in a litre of water. Copper requires 3·92 grammes of the sulphate, and iron 4·95 grammes of pure protosulphate of iron to the litre of water. If a dark liquid is formed on adding $(NH_4)_2S$ is added, the colour will disappear, on adding a few drops of dilute [illegible] does not disappear it is either lead or copper can be thus detected in a gallon. If the colour is persistent after the acid [illegible] should be condemned as not [illegible] may be present by [illegible] the water should [illegible]

grains of lime in each gallon of the water which is under examination.

The standard solution is made by taking 10 grammes of castile soap and dissolving it in a little weak alcohol, and then testing with a known solution of lime in water until the strength of the soap solution is obtained. (Mem.: a gramme equals 15·43 English grains, and a litre is 1·76 English pints.)

The hardness of a water is described as being of two kinds, the temporary and the permanent.

If water is boiled for some time, it deposits more or less of the carbonate of lime, which exists in solution as a bicarbonate, which salt is unstable at 212° F. Boiling softens water by driving off one atom of the CO_2, and by that means the carbonate not being soluble is thrown down. The salts left in solution are the sulphates and the chlorides and the magnesia salts, which are the causes of the permanent hardness of the water. The results, especially as regards the magnesia salts, are approximative only, but they are of considerable assistance in arriving at the potability of a given water supply. If the permanent hardness shows a residue of 8 or 9 grains per gall. it is not a good potable water.

Hard water may be softened by what is called *Clark's process*, which at the same time assists to purify it, by throwing down organic matter which may be in solution or suspension in the water Milk of lime is added until the excess of CO_2 in the lime salt is neutralised, and the whole is precipitated as a monocarbonate. It is a very easy process, and can be carried out without entailing any great expense, even in private houses, whilst the advantage of using softened water for dietetic and washing purposes must be manifest to all. The only important point is to get an accurate analysis of the water, showing how many grains of lime there are in each gallon, then find how much milk of lime is requisite to be used until a sample of the water gives a brown precipitate with a solution of nitrate of silver, instead of the white precipitate which ordinary hard water produces, and a simple sum will tell how much lime-water must be used for each 1000 gallons of water to be softened.

The precipitate soon deposits, and the clear, supernatent liquid should be syphoned off.

The total hardness of a water divides itself, therefore, into the temporary or removable, and the permanent or fixed hardness. The major portion of the temporary hardness is removed by the softening process as well as by continued boiling.

Phosphoric Acid and *Phosphates*.—The presence of these salts are evidences of serious contamination. Incinerate the residue left after evaporation, and add a few drops of HNO_3, and a little water, then filter. The filtrate should then be mixed with an equal quantity of solution of molybdate of ammonium. There will be either colour, turbidity, or definite precipitation, according as there are traces or more distinct evidence of the presence of H_3PO_4 in the water. The presence of distinct traces of H_3PO_4 is indicative of sewage contamination.

Oxidisable Matter.—This may be qualitatively determined by the use of potassium permanganate. It is a rough-and-ready means by which bad water may be rapidly condemned, but it does not follow that water which stands the test is fit for use. The colour of the solution is discharged more or less rapidly according to the quantity of oxidisable matter in the water, and calculations are made as to the quantity of oxygen which the permanganate provides and which is required for oxidation. The permanganate process does not act upon many substances, such as starch, urea, sugar, or gelatine, and is not in itself sufficient to prove a given water to be pure.

About half a litre of the water to be examined should be acidulated with a few drops of HCl and a solution of permanganate of potass of such a strength that ten minims should contain $\frac{1}{100}$ of a grain of oxygen. So long as the colour is discharged there is oxidisable matter. As soon as the colour produced by the addition of the salt fails to be bleached the limit is reached, the quantity of oxygen required is known and the amount of contamination may be easily calculated.

Water Filters.—Water is purified on a large scale by the London and other water companies by means of large filter-beds made up of a series of layers of coarse gravel, fine gravel, and sand. It is found in practice that there is a limit as to quantity, which filters must not be allowed to pass, and that a bed will not purify more than 700 gallons per square yard in the twenty-fours hours, unless the filtration is frequently intermitted so as to allow of aeration of the filter, and of the removal of the thin deposit of matter which is found upon the surface of the sand, if the water contains a perceptible amount of impurity. A properly constructed filter will purify for a short time only, it will remove matters in suspension for a much longer period, but it will not oxidise or destroy organic matters in solution unless the process is very frequently intermitted.

The action of a filter on a large scale can be mechanical only, for if the water is so impure as to be unfit for drinking purposes in consequence of the organic matter in solution before filtration, it will not be made potable by simple filtration through sand, unless the process is very slowly conducted, and the thickness of the filtering medium many yards instead of the few feet which is generally provided.

The best filtering mediums for small filters are all liable to foul from continued use, and should never be trusted for anything more than temporary purposes. Animal charcoal properly washed is the best, but the silicated carbon filter is capable of acting equally well with animal charcoal, the patent carbon filter of Atkins and Co., and other forms of charcoal filters. Dr. Parkes was of opinion that the only efficient filters were those made of magnetic carbide or animal charcoal, but filters of all kinds are only temporary means for purifying water. The charcoal after use for a few weeks should be purified by exposure to the sun and air, or else be placed in a furnace until it has been completely heated to a temperature of 300 degrees. Water which has been boiled for some time is both purified and softened, which action will be much more efficient than any filter in removing obnoxious matter from the water. It acts much in the same manner as Clark's process for softening, that is, it removes the extra atom of CO_2 and coagulates any albuminous organic matter which may be presen'. Alluminous salts are used in Eastern countries for the same purpose. Potassium permanganate or Condy's red fluid will remove smell from water, but will not precipitate the albumen.

Quantity of Water required for Domestic Use.—The London companies supply from twenty to thirty-five gallons per head per day for all purposes. The

town of Croydon has thirty-five gallons; some towns are content with twenty gallons, whilst others have thirty gallons. For ordinary domestic use twenty-five gallons will be ample, viz., ten for house consumption, five for baths, six for W.C.s, and the rest for waste, which is more or less unavoidable. Hospitals should have not less than thirty-five to forty gallons per head, but in prisons and other places under complete control of responsible officials it is found that twelve gallons per head per day gives a good allowance.

Kind of Service.—Water from surface-wells is sure to be contaminated at all times if they are situated in populous districts, whilst that from deep wells and borings, if preserved from surface pollution, will chemically vary only according to the geological character of the collecting ground and the nature of the strata from which it is obtained.

Artesian Wells are those wells of greater or less depth in which there is a collecting ground at a higher level than the site of the well, and which is some distance, it may be one hundred miles, from it; the water is kept down by a superincumbent impervious strata, which being designedly pierced, allows the water to rise directly to the surface without the necessity for pumping power. All towns of any size are now supplied by waterworks, the water being obtained from mountain-streams, rivers, lakes, or artificial collecting-grounds, and conveyed to the place of distribution by iron pipes. Storage works are necessary, according to the requirements of the situation.

Reservoirs may be open or covered according to the character of the neighbourhood, but they must be preserved from contamination as well as the wells and streams. They should be so situated as to command the town to be supplied, so that the water may run down by gravitation for the purposes of distribution, so as to avoid, if possible, the expense of pumping. The mains are of cast iron. They are generally coated inside with pitch to preserve them from the corroding action of gases and some salts which are found in almost all waters.

It should be the custom to avoid having dead ends in main water-pipes; that is, there should be a circulation round and round so that the water should never have the opportunity of becoming stagnant. A service is said to be *constant* or *intermittent*, according as to whether the supply is drawn direct from the main, or is first conducted into a cistern. A constant service is much more likely to be a pure service if the supply is pure to start with, for intermittent supplies are much more liable to contamination, either by means of the cistern fouling, or in consequence of the pipes becoming exhausted, and allowing of the regurgitation of foul matters into an exhausted receiver. Service by means of cisterns is not a good service; it is wasteful also, and the water is so liable to contamination, that cisterns should not be tolerated except in connection with the w.c. No w.c. should be allowed to draw its flush of water direct from the main, because there is a danger in the plan which cannot always be averted. It is the custom to use a so-called water-waste preventive cistern holding two or three gallons of water, and which is discharged every time the closet is used. The best kinds of water-waste preventive cisterns may be seen in action every day at the Parkes Museum, 74a, Margaret Street, London. All students who are getting up this subject should visit that depôt and see the machines in operation, and make themselves acquainted with their details by actual inspection. The Museum is open daily free of charge. All kinds of fittings connected with water-supply are to be seen there, the best way of arranging for water-supply to baths, closets, urinals, and lavatories are also to be seen and should be personally inspected. No water for potable purposes should ever be drawn from a w.c. cistern.

The house fittings are generally of lead; but in those towns in which the water-supply is very soft lead is not admissible. The bicarbonate of lime allows the pipes to become coated with an insoluble carbonate of lead which protects the metal from further action. If the water is very pure, the lead is dissolved by it, and carbonate of lead itself may be taken up, whilst if the water contains any quantity of nitrates, these attack the lead and cause much mischief if the use of such water is continued. It does not answer to store rain-water in lead cisterns for the same reasons. Slate makes the best storing medium; care must be used also not to allow of leaden covers even when the water is hard, as the heat on a summer's day tends to a good deal of condensation of distilled water upon the metal, which, having dissolved some of the lead, will drop back again into the cistern and contaminate the whole supply. Iron fittings are more advantageous as being less liable to derangement and rupture in frosty weather. It is curious to note the great inattention which is paid by plumbers to the possibility of frost. The pipes which convey water into a house are generally so placed that the water must freeze in them whenever the temperature sinks for any time below the freezing-point. Water-pipes should always be protected from the effect of cold, and an arrangement should be made by which they may be emptied in frosty weather, so as to obviate this risk, and then the mischief which follows upon a thaw may be altogether prevented.

(To be continued.)

—o—

The New Class-Subject, 'Elementary Science.'

(What to teach, and how to teach it.)

BY RICHARD BALCHIN.

THE facts, and the methods of presenting them, for the lessons included in Chapters V. to XIV. are given with sufficient fulness in the 'Science Reader' for Standard IV.

I now pass on to the series of lessons in connection with Chapters XV. to XVII. These deal with the classification of the sub-kingdom, 'vertebrata' or backbone animals. It has always appeared to me that the subject of Natural History or rather 'zoology' has been very imperfectly treated in our schools. It is true, we have a plentiful stock of pictures and illustrations; and lessons on 'animals' are common enough, especially in the lower standards. But these lessons have invariably taken the form of anecdotal descriptions of the appearances, habits, and uses, of certain members of the animal kingdom. Moreover, in the case of such lessons, I have never been able to detect a plan or system. One day we have a lesson on the 'elephant,' then on the 'salmon,' followed by one on the 'eagle,' and so on; and this is the case, not with the lower standards only, but also with the upper ones. We

never get to what I may call the 'biology' of the subject. We never touch the *science* of animal life. And yet we live in the days of a Darwin and a Huxley. 'What *is* a fish?' 'In what respects does a bird differ from a bat?' are questions which could not be answered by one in a hundred of the boys in even our upper standards—boys who probably find their class-room walls adorned with very beautiful pictures of these and other creatures.

In the series of simple lessons I am now about to describe, this defect is sought to be remedied. I am of course perfectly aware that we cannot conveniently include in our lessons the very foundation of all biological knowledge; I mean dissections and microscopic work in connection with cells, vessels, tissues, etc.

What I think *may* be done in Standards IV. and upwards is as follows:—

First, to make as clear as possible the distinction between the vertebrata and invertebrata.

Second, to begin with the vertebrata, as being the easier of treatment and more within reach, and explain the basis of our classification of this sub-kingdom.

Third, to classify the vertebrata into (*a*) fish, (*b*) amphibians, (*c*) reptiles, (*d*) birds, (*e*) mammals.

Fourth, leaving out of consideration the skeleton, to take the organs engaged in respiration and circulation, the skin and its covering, the mode of bringing forth the young, and to show in an elementary fashion the gradual advance in structure of such organs, from the lowest fish (the lancelet), to the highest mammal (man).

Fifth, to show that the five classes of vertebrates have appeared one after the other, in successive geological periods. I mean that there first of all came upon the scene 'fish.' That is to say, there *was* a time (the silurian age) when fishes were the only vertebrate animals tenanting the globe. On the dry land there were as yet no members of this sub-kingdom. Afterwards (the beginning of the carboniferous age) amphibians put in an appearance. They came up out of the waters. At this time, fish and amphibians were the only vertebrates terrestrial. Then there followed (in the Permian age) reptiles; these probably had dominion over all the others. We reach birds, in the next age; and, lastly (in the new red sandstone), we can just detect the dawn of mammalian life. Of these, the first to appear are among the lowest in the class—opossum-like creatures; and the last to appear is that most highly organised mammal, man himself.

At this point in my article, the reader will probably throw down the book and cry, 'Impossible!' 'Can't be done!' 'Flat evolution!'

Now it *can* be done, because I have *done* it. And as for evolution, I never so much as mention the word to fourth-standard boys. What I certainly *do*, with respect to this great law, is to lay before the scholars a series of facts which shall prepare their minds to grasp and accept this wonderful discovery respecting life-progress.

It is to me quite delightful to watch the attentive and sparkling eyes of some of the boys. These youngsters are greedily devouring—if I may so speak—the facts, which are to them all so novel. A few days ago, in one of my lessons, I was just glancing at the heart-development as it is exhibited in the five classes of the vertebrata. Of course this was done in a very elementary fashion. In the lowest fish—the lancelet—there is a series of pulsatory swellings of the main blood-vessel; each swelling answering to a heart of *one* chamber. I illustrated its action by alternately squeezing and relaxing a piece of india-rubber tube, and so propelling water along it. In the vast majority of fishes the heart is of *two* chambers; I described them and their action. In the amphibians (*e.g.*, a frog) the heart is first two-chambered, like a fish; afterwards three-chambered, like a reptile. In the lower forms of reptilian life the heart is of three chambers, but with a sort of incipient division appearing in the one ventricle; and this division is, in the highest of the reptiles, quite complete; and *their* heart is four-chambered, like that of birds and mammals. The boys were quite able to follow me as I drew roughly on the blackboard, diagrams of these progressively-organised means of circulation. Surely this definite, scientific teaching, although, I admit, it was of necessity almost painfully elementary, is yet worth all your anecdotes and legends about animals.

The following are outlines of lessons in this series, which, perhaps, it would be as well if I numbered separately from the others in the course for Standard IV.

LESSON I.

VERTEBRATA AND INVERTEBRATA.

Some animals *with* backbones; fish, snake, dog, etc. Some animals without backbones; worm, oyster, etc. Show backbone or part of one, of fish or rabbit; not one piece, several pieces. String together a number of empty reels (cotton reels) as an illustration; or, better still, get the boys to bring a number of india-rubber rings, such as are found in the necks of a certain kind of lemonade bottles: glue the reels together with the indiarubber rings between: this gives a flexible column. The reels represent the vertebræ, and the rings the vertebral cartilage. (*Note.*—One of the boys, seeing his teacher construct such an illustration of the backbone, made one himself at home; but added something which I thought very ingenious. He passed a length of worsted from a ball of worsted down through the holes of the reels, leaving the remaining unrolled portion of the ball at the top of the column. The worsted, passing down the channels of the reels, represented the spinal cord, and the ball in connection with it, the brain. The only defective part of the boy's illustration was that the neural canal would appear to pass through the centrum of each vertebra, which, of course, it does not.)

Each piece of the backbone is a vertebra, hence the whole is called the vertebral column. All animals with such a bone are vertebrate animals. 'In' means 'not.' All animals without such are invertebrate animals. Describe more fully this vertebral column and its appendages, as figured on page 56 of Science Reader for Standard III.

LESSON II.

CLASSIFICATION OF SUB-KINGDOM 'VERTEBRATA.'

Recapitulate the ideas respecting classification in general as given in the 'Reader' for Standard III. Lead up to just such a classification of vertebrate animals as I have found generally suggests itself to boys. Namely:—(1) animals that fly; (2) animals that have to keep to the ground; (3) animals that swim. In other words, *birds, beasts, and fishes.* Show, by a string of questions, the defects of such a classi-

fication. Thus:—Where should we place the emu? It cannot fly, and yet is a bird. Or the bat? It *can* fly, and yet is *not* a bird. Or the whale? It lives in the water, and yet is not a fish. So lead to the conclusion that to take the *habits* of the animals as the basis of our classification is not satisfactory. Now show the school-picture (Murby's set) of the organs of the human body, and of a fish. Explain 'organ'; and describe briefly the functions of the heart and lungs. Compare lungs with gills. Lead up to the conclusion that a better basis for our classification than the 'habits' of animals would be the build or structure of the chief organs: in short, 'organization.' Taking the latter as the basis, we divide the vertebrata into five classes:—(1) Mammals; (2) Birds; (3) Reptiles; (4) Amphibians; (5) Fishes. Show—in a very general way at present—the manner in which the animals in these classes differ with respect to (1st) the circulation; (2nd) the respiration; (3rd) the skin covering; (4th) the manner of birth.

Note.—I generally find it necessary to devote two lessons to this subject, which, I may add, is an extremely interesting one to boys, although, at first sight, it may not appear to be so.

(*To be continued.*)

—o—

Article 106 (*b*).

Merit Grant in Infant Schools.

BY MRS. MORTIMER,

Lecturer on Kinder-garten at the Home and Colonial Training College, London.

Section II.—Phenomena of Nature.

LESSON—THE SNOW.

Now, children, we have had a talk about rain, and you can tell me which time of the year we like rain. In the summer-time. When else do we have rain? All the year round. Yes, it rains both in warm and cold weather. There is something else that falls from the clouds besides rain, and it only falls in cold weather. Can you tell me what it is? It is snow. Well, I want you to tell me all about the snow. It is white and soft. Yes, and does it come down like the rain? No, the snow does not fall at once. What do you mean? The pieces of snow seem to fly about after one another and then fall. What do we call the pieces of snow? Flakes. Yes, look now at the flakes of the snow—they seem to be chasing one another. How does the snow look when it is on the ground? Very pretty, and on the trees it looks prettier still. Yes, when it has been snowing all the things are white, and if the sun shines through the trees you will see the pretty glitter on all the branches. Do you like to go out when it has been snowing? Why? To play with it. What do you do? Make snowballs and throw them about. What do the big boys do? Sometimes they make snow men, and sometimes they roll a large ball over and over until it is so large that they cannot move it. How does it make your hands feel? At first very cold. Yes, but if you run about you soon get warm. What ought you to do after you have been out in the snow? If you look at your boots what do you see? Yes, they are wet and this wet goes through your boots to your feet, and if your feet are wet what generally happens? We catch cold. Yes, unless you take your boots and socks off and rub your feet well.

Some little boys and girls do not like feeling so cold, so they bring the snow to the fire. What happens then? The snow melts. What do you mean by that? The snow turns into water. What makes the snow melt? The fire. You see then, if you want to play with the snow you must not mind going out in the cold. And if you put your thick coats and scarves on and run about you will get warm. Sometimes after it has been snowing the weather keeps very cold, and then what happens to the snow on the ground? It gets very hard, and we can walk on it without sinking into it. What happens to you then? We sometimes fall down. How is that? The snow is slippery like ice. What do the big boys do? They run along and slide over the snow. The teacher might here show a picture of a sleigh, and describe what fun the boys have in very cold countries, and how the snow helps the people to get about from place to place.

Sometimes when it has been snowing all day you go to bed and think you will have such fun in the morning with the snow—then when you get up and look out of the window you see the sun shining but no snow. How is that? Where has it gone? It has thawed. What do you mean by that? How does the snow look when it thaws? It looks very dirty and makes the roads very muddy. Who clears away the dirty snow? Yes, you see men and boys with brooms and shovels. They knock at the doors and ask the people inside if they want their paths cleaned. What must you give these men or boys? Some money. If the snow has been on the ground some time and been walked on it is very hard to clear away, but if it has only just fallen it is easily swept away.

How can we tell when we are going to have a snow-storm? The clouds are very thick and dull and it feels very cold. What do we generally get from the clouds? Rain. Yes, but sometimes when it is very cold, before the clouds turn into rain, they become frozen and in this way the snow is formed. You will have to learn more about this when you are older. You have never thought that the snow is very useful, have you? Well, when the snow falls it keeps the ground warm, and the plants that are in the ground are then able to stand the hard frost. If the plants were frozen they would die. Then when the snow melts the water goes into the ground, and this gives the plants food, and makes the ground better for the flowers, etc., that grow in the warm weather.

Section III.—Common Employments.

LESSON—THE POSTMAN.

Now, children, we are going to talk about the postman. Who is the postman? The man who brings us letters. How do you know a postman? By his dress. Tell me what kind of clothes he wears. He has dark-blue cloth clothes with a little red on them. Where is the red? His trousers have a red stripe on the outside. Then he has some on his coat-collar and also on his coat-cuffs. What about his hat? He wears a peaked cap, and this also has some red on it. Have you not seen something else on his cap? Yes, there are some letters and figures. Who can tell me what letters are on the postman's cap? He has G.P.O. on it. I do not expect you know why the postman has these letters on his cap, so I will tell you. There is a very large post-office called the General Post Office, which is the largest in England. He has these letters to show that he belongs to the General Post Office. Then the postman has letters on his coat-collar. Have you ever noticed any? Sometimes you will see N., sometimes S., sometimes E., and W., and a few others. Who can tell me what these letters mean? That is quite right, N. stands for North, S. for South, E. for East, and W. for West. The postman who has N. on his collar takes the letters to the north of London, the one that has S. has to go to the south of London, etc.

London is divided into ten parts, and there are different postmen for each part. Now tell me how many different sets of postmen there are? Ten. How many letters did we say? Four. What were they? North, South, East, and West. Yes; then how many more do you want? Six. We will write the letters on the slate, and another day you must try to learn all about them. The letters are N.E., S.E., N.W., S.W., W.C., and E.C.

What does a postman carry with him? A bag. What does he put in the bag? The letters, and he generally

has one packet in his hand. What does he do with them? He leaves them at the different houses. How do you know when the postman comes to your house? He gives a postman's knock. Show me how the postman knocks? Yes; it is quite different to any other knock. What kind of knock do you call it? A sharp double one. How does the postman walk along? Very quickly. Why? Because he has a great many letters to leave, and he must make haste, for we do not like our letters to be late. Has the postman any other work to do besides going out with the letters? What is it? He goes to the letter-boxes to collect the letters. Where are the letter-boxes? In the streets. What are they like? Large red round posts, with a hole near the top to put the letters in. How does the postman get them out? He opens a large door, and then they fall into his bag. Does the postman get the letters from any other place? Yes; sometimes the postman goes to the post-offices. Where are they? At different shops. What kind of shops? Stationers', grocers', and tobacconists'. Yes; then there are the large post-offices that are only used for post-offices. There is one of these large post-offices in each district in London. How many districts did we find out? Then there are ten District post-offices, besides that very large one I told you about. What is that called? The General Post Office. Now, you said the postman collects the letters. What does he do with them? He takes them to the district office, and there the letters have to be sorted. What do I mean by sorted? Yes, that is right; a great many people put their letters into the post, and they are sent to different places. Now, the postman could not take them all to their right places. Why not? Because he would be too long, and he would be tired. So the letters are sorted. All the letters for London in one place; those for different parts of the country in others, and so on. Those for London are sorted for each district, and the postman has the letters for a few streets only given to him. Before they leave the office they are marked so as to show they have been through the post-office. The country letters are packed in sacks, and carts take them away. Who has seen the post-office carts? What colour are they? Do you know what we call them? We say they are mail carts. Where do you think the mail carts take the letters? To the railway station. Yes; and they are taken into the country by the train. Some of these trains are called mail trains, and there is a separate carriage for the letters. If you were to peep into one of these carriages you would see the postmen sorting the letters. When they come to the stations they leave the letters for that part of the country, and then get the next packet ready; so you see these men are very busy. Do you know how they fasten the bags? Yes; with a piece of string. They also put some sealing wax on them and then stamp them.

Do you know who is the postman's master? That is right; he is one of the Queen's servants. I dare say you have seen something written on the letter-carts. What was it? Two letters, 'V.R.' Yes; and two words, 'Royal Mail.' These letters and words all show that they belong to the Queen.

Now I want you to tell me what kind of man the postman ought to be. He must be quick. Why? What else? What must he do before he takes a letter to a house? He must *read* the outside. Yes; we say he must read the address. Then if the people have moved away, he has to *write* something on the envelope. Do you know what he would write? He writes, 'Not known,' or 'Moved away.' Then you see a postman must be able to read and write. The postman has many letters to carry, and sometimes there are other things in the letters. Tell me something we send in letters. Money, pictures, etc. What kind of man must the postman be to have charge of these things? He must be honest. Yes; we have to trust him very much, but then we all must be honest. Cannot you think of anything else? He must be clean and very careful.

There are a few ways in which we can help the postman. Can you tell me any? What should we do when we hear the postman's knock. Run quickly to the door so that the man does not have to wait. Then you told me that he has to read the addresses on the envelope, so what should we do to help the postman? Write very plainly, and be very careful to put the right name of the street and the number of the house. Sometimes the house has a name instead of a number, and we must be sure to put the right name on the letter. How does the postman manage to read the addresses at night? He has a lantern. Yes; and this also helps him to see the numbers of the houses.

Section III.—Scenes of Common Life.

LESSON—THE RAILWAY STATION.

Apparatus: Picture of station, model showing railway and station with engine and carriages; a few tickets.

What part of the year do you have the longest holidays? What do you do in your holidays? Some of you play in the parks and in your gardens and some go into the country. Now I want those of you who went into the country for the last holidays to answer me and tell all the other little boys and girls about what they saw. How did you get into the country? Yes, you had to go in a train, and the train runs along the railroad. Can any of you tell me how the railroad is made? Of what is it made? Of long pieces of iron. Yes, these pieces of iron or steel are called rails. Teacher showing the model would direct the children's attention to the way the rails are laid on the long thick pieces of wood, and if a good model is being shown the shape of the 'chair' should be pointed out and the way the chairs are fastened to the 'sleepers' should also be shown to the children. The rows of rails are called lines. How many lines of rails do you see? Four lines. How many does the train run on? Two lines. For what are the other two? For the trains running the other way. Yes, it would not do for them to run on the same lines. Can you tell me what would happen if they were to run on the same lines? The trains would meet together. The teacher might here allude to accidents caused in this way. Where else do you see lines of rails? In the streets. What do you call them? Tramways. Do the engines go on them? No, the trams are pulled along by horses. The teacher might here show the advantage of engines to horses and also the danger of using them in the streets.

You have told me all about the railroad, and now I want you to tell me about the train. What is the first part of the train called? The engine. What does this do? It pulls the carriages along. Now look at the engine (picture or model to be shown); tell me some of the parts of it. The chimney, the boiler, the tender, the large fire. Yes, you see there is smoke coming out of the chimney. What comes out of the boiler? You do not know; well, when the kettle boils what comes out of the spout? Steam. Well, that is what comes out of the boiler, and it is the steam that makes the engine pull the train along. What can you see in the tender? The coals. For what are they used? To make the large fire boil the water. What do we call these large fires? Furnaces. How many men are there on the engine? Two. What would you say of them? They look dirty. What makes them dirty? What work do they have to do? Yes, one of them is called the engine-driver, and the other one is called the fireman or stoker. What has he to do? He has to keep up the fire. What would happen if the fire were to go out? The water would stop boiling, then there would be no steam, and then the train would stop. You see therefore that the fireman has to be very careful to keep up a good fire. Then he has to help the engine-driver to clean and oil the engine. If you were often to see an engine you would see the man with his large oil-can oiling the different parts. You must learn more about the engine another time.

What did you tell me comes after the engine? The carriages. How are they joined to it? By thick chains.

Now look and tell me if all the carriages are alike. No. Some are very much nicer than others. What do we call those very nice ones? First class. How many other kinds are there? Generally two others. We say there are first, second, and third class carriages. Which do you ride in? Why do you not ride in the first class? Now, quite at the end of the train there is a carriage into which you are not allowed to go. Do you know the use of this? Yes, it is for the guard. Who is the guard? What does he have to do? He is in charge of the train. He has to see that all is right. Very often there are two guards to each train. Do they both go into the same carriage? No, one is at the end of the train and the other is in front next to the engine. Do you know what the guard's carriage is called? Yes, the brake. If you were in the brake with the guard you would see that he turns a wheel just before the train comes to the station. This wheel is joined by a chain to pieces of thick wood near the wheels of the carriages. These pieces of wood then stop the carriage-wheels from turning round and this helps to stop the train. You would also see large windows at the back and sometimes at the top of the brake. The guards look out of these windows to see if all is right.

We have been speaking about the train, and now I want you to tell me what we have to do if we want to go in the train. If you were going to the train to what place would you go? To the railway station. Yes; and when you get to the station what do you have to get? A ticket. Where do you get that? At the ticket-office. Yes, you go to the little window and look through. You see a man inside, and he gives you the ticket. What do you give the man? Some money. Why do we have to give him money? To pay for our ride. Why does he give you the ticket? To show that we have paid for the ride. If you look into the office you will see a large number of shelves and piles of tickets. Did you notice what the man did to the ticket before he gave it to you? Yes, he put it in a machine. This little machine prints the date of the month upon it. Mary says the man cut the ticket with the scissors. Why did the man do that? Because she is a child. Yes; children only have to pay half as much as men and women, and so they have half-tickets. What have we to do next? Go on to the platform. Yes, but before you go on to the platform we have to show our tickets to a man. What does he do to them? Why? To show that he has seen them. What did he use to clip the tickets? A pair of pincers. They are something like pincers. What do we do next? Does the train come on the platform? Where then? By the side. On which part of the platform ought we to stand? On the part farthest away from the train. Why? What do you see on the platform? There are some seats. Why are they here? For people to sit down while they are waiting for the train. What else do you see? Sometimes there is a bookstall. Why do they have bookstalls on the platforms? For the people to buy books and papers to read in the train. Sometimes there is a refreshment room. What is the use of this? Can you tell me anything else you see on the platform? Well, what do you call these men? They are called porters. What have they to do? They open and shut the carriage doors, and answer any questions that they are asked about the trains; they carry the luggage, and they have to keep the station clean. How can you tell the porters? By the clothes they wear. Do the porters always stop on the platform? No; sometimes you cannot see one. Where are they? They go into a room on the platform. May you go there? No. Are there any rooms that you may go in? Yes. What are they called? Waiting-rooms. When must the porters be on the platform? When the train comes in. What do you do then? Wait until the train has quite stopped, and then get into the carriage. What happens then? The porter shuts the door. When does the train start? Yes, you hear a whistle. Who blows it? The guard. The engine-driver, when he hears it, lets off the steam whistle, and turns on the steam, and off goes the train. Where does it stop? At the next station. When it gets to your station what do you do? Sit still until the train stops, and then we get out on to the platform. What do you do before you leave the station? Give the ticket to one of the porters who is called the ticket-collector.

Note I.—The station-master has not been mentioned. The teacher might tell the children that at every station there is a head man, called the station-master, who has to see that the porters do their work, that the trains start at the right time, etc.

Note II.—The signalman and his work would almost form the subject of a separate lesson.

(To be continued.)

—o—

Physiology.

BY ARTHUR NEWSHOLME, M.D. LOND.,

Gold Medallist and University Scholar, Physician to the City Dispensary.

CHAPTER IX.—DIET.

THE four chief elements entering into the composition of the body are carbon, hydrogen, oxygen, and nitrogen. In addition to these there is present a smaller amount of sulphur and phosphorus, and of certain salts. These elements are constantly being oxidised in the system, and subsequently eliminated from it. To compensate for this continuous loss, a corresponding replacement is required. If the elements could be taken *as such*, the question of diet would be very simple. Nitrogen and oxygen are present in abundance in the air and charcoal is easily obtained, while water consists of hydrogen and oxygen combined. But animals possess no power of elaborating from elements or inorganic compounds, the more complex organic bodies of which their tissues consist. The only element which is taken as such is oxygen, and this through the lungs, and not the alimentary canal. With the exception of salt, all other foods require to be *organic* in character. In this respect animals differ remarkably from plants, which elaborate complex organic substances from carbonic acid, ammonia, and inorganic salts; animals requiring vegetable food, or food derived by other animals from vegetables.

The five chief classes of food are—

(1) Nitrogenous Foods.
(2) Hydrocarbons or Fats.
(3) Carbohydrates or Amyloids
(4) Salts.
(5) Water.

These have been commonly divided into *tissue-producers* and *heat-producers*, the first class replacing the waste tissues of the body, and the second supplying combustible material, the oxidation of which maintains the heat and other forces of the system. The two classes are, however, not mutually exclusive. All tissue foods by their oxidation produce heat, while fats and carbohydrates doubtless help in the building up of new tissues, as well as in the direct production of force.

There are certain foods which do not directly serve as tissue or heat producers, but which are essential for promoting the assimilation of other foods. Thus water although already oxidised, and therefore incapable of generating force, is absolutely essential to the digestion and assimilation of food, to the interchange between the blood and various tissues, and to the elimination of effete matters.

Nitrogenous Foods include albumin, casein, gluten,

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The passages of Greek and Latin set from books not previously mentioned at the examination just concluded are given in another part of this number of the Practical Teacher. A translation of them will appear next month.

French.—All who read these notes have no doubt made some progress in French. We need not therefore give directions to beginners. It may fairly be said that French is at the same time both easy and difficult. It is a language of which most people know a little, and few very much. Anything like sound instruction in French is very hard to get anywhere. In most cases the pupil must become tutor and use his French-master to give him the pronunciation of the words and the correct rendering of the sentences. The matter of pronunciation may seem of no importance with a view to a written examination. This is not so. It very much assists the memory to repeat aloud as well as read and write the grammatical forms and the examples to the rules of syntax; and without some knowledge of the sounds the student will rarely read aloud. A knowledge of French is becoming of more and more importance, both for pleasure and profit. In most cases it will not be taken up specially with a view to pass the examination. The student will not begrudge the time he spends upon it, nor be always on the look-out lest he should do too much. And let it be added his chances of success will be very much increased thereby; for it is not easy to say exactly how little will just secure a pass, and we would recommend nobody to try to find out for himself.

The student who tries to exercise his own judgment as to the books he will use and the methods he will adopt is sure to be struck and possibly confused by the disagreement of his guides. And this confusion will be all the greater if he fails to recognise that they are not all aiming at the same result. With some the ability to understand a few simple sentences and to reply to them is considered to be of more importance than being able to translate correctly a page of Molière. At that rate an English child of eight may be said to know English better than the foreigner who is able to understand the masterpieces of our language, but not able to converse fluently in it. And there can be no doubt that if conversational fluency is all that is required, our ordinary methods might be revolutionised with advantage. In order to acquire rapidly, and know perfectly the comparatively few things that would be necessary, we might be content to remain in ignorance of the thousand useless details that now fill the grammars and dismay the pupils: But with many the power to read and write French is of more importance than the ability to converse in it, and our methods must vary accordingly. While the requirements of examiners should not be too carefully studied, they should not be entirely disregarded. Most of us in this much-examined nation are at the present time, to some extent at least, *servi servorum*, the slaves of examiners who are not free themselves.

The examination in French consists of three passages of French, two of which have to be translated into English. There are also grammatical questions mostly restricted to the accidence upon the passages. There is no one book that can be recommended as much better than many others. When some such work as Smith's 'French Principia,' Pt. I., or Fasnacht's 'Progressive Course,' Pts. I. and II., has been mastered, reading should be pursued with vigour. Smith's 'Principia,' Pt. II., has an excellent vocabulary clearly printed. The extracts are followed by useful questions, which should be studied. Private students would do well to procure the answers from the publishers. Another reading-book containing similar extracts, but without questions or vocabulary, is the 'Modern French Reader,' published by Trubner, 2s. 6d. If the student gets tired of short pieces, he may try the selection from About's works, published by Hachette, 2s. 'First Lessons in French,' by H. C. Bowen, 1s.; and Prendergast's French in the Mastery Series, 2s., are both useful, and without taking too much notice of the directions at the beginning, which are impracticable for nine persons out of ten, students would learn from these two books what they will most likely not get elsewhere.

A few good grammars deserve notice: we call attention to Eve and Baudiss's, Fasnacht's 'Synthetic Grammar,' and Brachet's 'Historical Grammar.' Contanseau's Dictionary is clearly printed and quite full enough for ordinary purposes, so is Cassell's: Spier's, in two volumes, Littré's 'Abridgment,' and the 'Pocket Dictionary,' by John Bellows, are books which should be remembered and examined when opportunity serves. The student can then judge which will suit him best.

Natural Philosophy. — The student is recommended to get a balance and a set of weights; most likely he can have access to them without buying; no large school should now be without them. Good work can be done with inexpensive apparatus. The main point in a balance is its sensibility, *i.e.*, its readiness to turn upon the addition of a very small weight. To secure this there should be little friction, and the beams should be as long and light as is consistent with their remaining rigid when carrying the heaviest weights they are intended for. The arms should be of exactly the same length. We can see at once if they are so by putting two equal weights into the two pans. If one arm is longer than the other, the pan which is attached to it would descend.

The student is no doubt aware that if the arms were of unequal length, he could still obtain the true weight of a body by weighing it first in one scale and then in the other, and taking for the true weight the square root of the product of the two apparent weights. A better method is to put the body to be weighed in one scale pan, and counterpoise it with white sand, then remove the body and put weights to counterpoise the sand. These give the weight of the body.

This is called *Double Weighing*, and is a very accurate method.

Let now a considerable number of objects be weighed for practice, such as coins, pieces of metal, glass, and stone. Weigh a bottle when empty, and again when full; the difference will give the weight of the liquid in grammes, and then, such is the simplicity of the metric system, we can state at once the capacity of the bottle, because a cubic centimetre

of water weighs a gramme. Now attach a fine wire to one arm of the balance, and fix on the other end of it a piece of metal. Weigh the metal in air first, afterwards weigh it when it hangs in the water; notice the loss of weight. This loss of weight in grammes gives us the volume of the body weighed in cubic centimetres. Conversely take a body that can be easily measured, and find its volume in cubic centimetres, then weigh it successively in air and water; it will be found to lose as many grammes in weight as it occupies cubic centimetres in volume. This is a verification of the law of Archimedes, that bodies immersed in water lose a part of their weight which is exactly equivalent to the weight of the volume of water they displace. If we know the weight of a body when weighed in water, and also the volume of the fluid which it displaced, we can calculate its weight in air by adding on the weight of the water displaced. We shall return to this subject when dealing with specific gravity. Meantime, it would be well to notice the effect on the weight of the body immersed if a considerable amount of salt be put into the water; and if the balance is sufficiently sensitive, the effect of substituting very hot for very cold water. Water is densest at 4°C., and if we call its density unity at 4°C., at 10° it is ·99974; at 15°, ·99915; and at 20°, ·99827.

It will, no doubt, have occurred that if a body weighed in water loses a part of its weight, equal to the weight of the fluid displaced, bodies weighed in air do the same, and it is so. And when we remember that a litre of air at standard temperature and pressure weighs 1·3 gm., which is the same as saying that a cubic foot weighs 1·3 oz., it will be seen that it is too much to be neglected where the greatest accuracy is required. As the weight of a litre of air will depend on the temperature and pressure, and also upon the amount of moisture in the air, it is necessary to read the thermometer and barometer, and find the dew-point in the room when such delicate experiments are made. For example, suppose a body weighs 50 gms. in air, we must find the volume of the body, and then the weight of the same volume of the air in which the body was weighed: let this be ·05 gm. Again, suppose the volume of the air displaced by the weights used weighs ·01 gm., then the true weight of the body in vacuo would be 50+·05−·01=50·04 gm. Corrections for the weight of air displaced are often unnecessary, but questions are occasionally set which imply a knowledge of them.

In studying the laws of falling bodies, an Attwood's machine is most helpful. The only essential part is a grooved wheel, turning with as little friction as possible. This is usually accomplished by letting the axle lie on the circumference of the other wheels. A watchmaker will generally supply the wheels, and help to fit them up. We advise the student to make a machine for himself. He will be amply rewarded for his labour.

(To be continued.)

UNIVERSITY OF ST. ANDREWS. L.L.A. EXAMINATIONS, 1884.—The results of the above examination have just been issued, from which it appears that 363 candidates entered for examination in twenty different subjects, and that of these eighty-one passed in the requisite number of subjects to enable them to obtain the title of L.L.A.

ANSWERS TO ALGEBRA QUESTIONS IN 'THE SCHOLAR,' FOR JULY, 1884.

EXERCISE XXXI.

(1) a^4x^8 (2) a^9b^{12}
(3) x^4y^{12} (4) $-a^9b^3$
(5) $\frac{a^6}{x^3y^9}$ (6) $\frac{a^6m^3}{b^3n^6}$
(7) $\frac{9a^2b^2}{16}$ (8) $\frac{1296a^4b^8}{c^4d^4}$
(9) $-\frac{x^6y^3}{27a^3b^3}$ (10) $-\frac{32a^5b^5c^{10}}{3125x^{10}y^5}$
(11) $x^3+xy+\frac{1}{3}y^2$ (12) $a^2-\frac{1}{2}ab+\frac{1}{16}b^2$
(13) $\frac{1}{8}a^2-\frac{1}{4}ax+\frac{1}{2}x^2$ (14) $x^2+\frac{3}{4}xy+\frac{9}{16}y^2$

EXERCISE XXXII.

(1) x^2; $5xy^3z^2$; $12a^2b^3$
(2) $\frac{3}{4}x^2y^2$; $\frac{1}{7}axy^2$; $\frac{1}{9}a^2bc$
(3) $81x^2y^2$; $\frac{1}{11}a^6b^6$; $\frac{1}{4}x^{12}y^6$
(4) ab; xy^2z; $\frac{x^2y^2}{z}$
(5) $2xy^2z^3$, $9ab^2c^3$, $\frac{3}{4}mn^2$
(6) $6ax^2$ (7) $7xyz$

ANSWERS TO ARITHMETICAL QUESTIONS IN 'THE SCHOLAR' FOR JULY, 1884.

STANDARD III.

A. 1. 2103+2.
2. 2565+5.
3. 1562+6.

B. 1. 24,658.
2. 6993+43.
3. 2456+52.

C. 1. 6818+159.
2. 85,513+74.
3. 82,004+19.

D. 1. £17 5s. 0d.
2. £322 2s. 6d.
3. £12872 11s. 10½d.

E. 1. £290 8s. 3⅜d.
2. £88,826 14s. 4½d.
3. £66 4s. 4½d.

STANDARD IV.

A. 1. £29 6s. 4½d.+77.
2. 2739 lbs. 1 oz. 3 drs.
3. 2250.

B. 1. £26,879 4s. 5⅝d.
2. 1,473,120.
3. £12 12s.

C. 1. £10 16s. 2½d.+14.
2. 803 fur. 28 po. 4 yd. 2 ft.
3. 606,528.

D. 1. £14,440,650.
2. 27,878,400 sq. ft.
3. 10,454,400 sec.

E. 1. £2 19s. 7½d.+11
2. 120 lbs.
3. £1861 10s.

F. 1. 12s. 0¼d.
2. 4s. 6½d.
3. 23 times.

STANDARD V.

A. 1. £233 16s. 10½d.
2. £2205 3s. 8d.
3. £3429 3s. 4½d.

B. 1. $3\frac{13}{14}$.
2. $4\frac{9}{16}$ oz.
3. £764,360 8s. 9d.

C. 1. (3s. 7½d.; £1 6s. 3d.; £8 12s. 6d.; 12s.); total, £10 14s. 4½d.
2. £1540.
3. $\frac{8}{9}\frac{8}{9}$.

D. 1. 64 hours.
2. (1s. 5½d.; 1s. 6d.; 7s. 10½d.; £11 18s. 8½d.) = £12 9s. 6½d.
3. £1162 11s. $11\frac{1}{10}$d.

E. 1. 84 lbs.
2. £490 10s. 10d.
3. $\frac{33}{13}$.

F. 1. £170 6s. 4½d.
2. (3s. 4d.; 4s. 4½d.; 9s. 4d.) = 17s. 0½d.
3. £23 12s. 6d.

STANDARD VI.

A. 1. 22; 414,480.
2. $\frac{1}{2}\frac{1}{3}\frac{2}{3}$.
3. £2069 14s. 6d.

B. 1. ·0003252.
2. £153 6s. 4½d.
3. 17·3; ·0173.

C. 1. 15s. 9d.
2. 33 ft.
3. £1 2s. $8\frac{83}{100}$d.

D. 1. £732.
2. $2\cdot1\dot{7}14285$.
3. £1000.

E. 1. 3185 halfpence.
2. ·0001092.
3. £11 3s. 1½d.

STANDARD VII.

A. 1. 4·675.
2. 12½ p.c.
3. £103 14s. 6⅝d.

B. 1. 1 oz. $4\frac{1}{2}\frac{3}{5}$ drs.
2. 5¼d.
3. £2600.

C. 1. 33⅓ p.c. increase; 12½ loss; 20 p.c. increase.
2. £3 1s. 5d.
3. £989 1s. $8\frac{4}{8}\frac{8}{8}$d.

D. 1. $\frac{1}{8}\frac{1}{8}$ or 5s. $9\frac{1}{11}$d.
2. $9\frac{1}{11}$.
3. £494 1s. $8\frac{3}{1}\frac{3}{1}$d.

ANSWERS TO ARITHMETICAL QUESTIONS IN 'THE LITTLE LEARNER' FOR JULY, 1884.

STANDARD I.

(1) 2660
(2) 802
(3) 171
(4) 2618
(5) 292
(6) 195
(7) 678
(8) 90
(9) 583
(10) 1849
(11) 2698
(12) 4698
(13) 3794
(14) 144
(15) 92
(16) 3517
(17) 11
(18) 8
(19) 1704
(20) 481
(21) 698
(22) 3511
(23) 221
(24) 98
(25) 3810
(26) 95
(27) 457

STANDARD II.

A. (1) 351,166
(2) 243,579
(3) 187,276
B. (1) 9374
(2) 9266
(3) 13,034
C. (1) 691,355
(2) 778,437
(3) 393,778
D. (1) 1,210,006
(2) 3,340,302
(3) 5,704,314
E. (1) 71,075,400
(2) 59,770,200
(3) 95,596,160
F. (1) 2921+4
(2) 11,418+1
(3) 10022+6
G. (1) 1992+1
(2) 2918+1
(3) 2568+6
H. (1) 1330+35
(2) 663,674,000
(3) 34,323,870

The Discipline of the Mind.

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III.—ASSOCIATION AND MEMORY.

IT is characteristic of Mr. Herbert Spencer's treatment of Mind that he has striven to show how much may be learnt from even a hypothetical account of the Genesis of Nervous Systems, and what an increase of insight we obtain into mental laws when we unravel their physical conditions. Much has been written and surmised about the connection of ideas, but the larger part of such discussions has consisted rather of description than of explanation, and the real grounds of these connections have escaped notice through the fatal limitation of inquiry to the reports of inward self-examination. For although we freely own that in the last resort consciousness is the source of all our knowledge, the slow progress of mental science is a sufficient demonstration of the assertion, that to neglect the study of the organic conditions of Mind is to miss the clue to the understanding of some of the most familiar phenomena.

These remarks are peculiarly pertinent here, for on the one hand the trivialities which have passed for mental science, and on the other, the embarrassments experienced by psychologists alive to certain prevailing fallacies, but unable to replace them by sounder knowledge, might be largely illustrated from the treatment of Association and Memory. The usual instruction on the subject amounts to this, that it is erroneous to regard the mind as a 'store-house,' that impressions and ideas are not laid up as it were in a cupboard for further use, and that there are certain principles of association which, according to different authorities, variously range from one to a dozen.

With regard to the Laws of Association and Memory, attempts have indeed been made to justify the favoured number; but why there must be this number and no more, why there should be association at all, and wherefore the popular view is erroneous which regards memory as a kind of spiritual receptacle has been far from clearly seen. Now the truth of the matter is simply this, that the permanent element is not mind at all, but a more or less settled material fabric, a connected nervous system, the degree of whose elaboration rigidly determines the extent of the mental powers. In a rudimentary nervous system, the various parts of which are very loosely connected, a very low state of mind will alone be possible; but at a further stage, where nerve-bundles are consolidated and the inter-dependence of distinct centres is effected by very definite communications, not only will the retentive power be strengthened, but the recall of the past be correspondingly facilitated. Ideas *as* ideas have no permanent existence, they only survive the brief moment of conscious apprehension, but a very similar state of consciousness can be brought about if the old nervous tracks be struck upon, and if the various nervous connections are in good working order.

A glance at the anatomical relations renders at once intelligible the important part played by association in the mental life. It is almost impossible to stimulate the nervous system either centrally or peripherally without the influence being propagated in various directions, determined primarily by the structural connections, and secondarily by the intensity of the shock. Experience tells us that nothing is more difficult than to confine the thoughts to a limited area. To check the spontaneous flow of feelings, to forbid the natural conjunction of ideas, may often require considerable effort, and when we are dealing with impressions of sense may even be impossible. The art of education may indeed almost be summarized as the art of facilitating or hindering psychical associations, and the limits of that act are inexorably defined by the given structural conditions.

It is fortunate for us that the *fatal* element, as one may call it, is thus dominant, for were these nervous connections not so determinate the acquisition of the simplest ideas would be enormously difficult. We require the co-operation of sense-impressions and muscular movement every moment of our lives, but the rapidity of these all-important acquisitions is, in most cases, out of all proportion to the amount of deliberate effort. As we get further away from sense, however, the bond of association is more difficult to forge, and the most prolonged endeavours may prove fruitless. Each period of life has its favoured associations, rendered possible by the degree of nervous development. In early life, when the organs of sense are far more developed than the brain, the sense-cohesions will be far more numerous and stronger than intellectual combinations. Such inward life as there is will consist of repetitions in imagination of past sensations and external impressions. Later on, when the ruts of custom in the region of sense are well worn, the mind will be less distracted by the brilliant setting of its pictures, and will come to dwell more upon the grey nucleus of constant properties. These recurrent attributes will haunt the mind, and

objects will be linked together through the possession of common properties rather than by mere external affinities.

Memory is so largely a case of association that the 'Laws of Association' are usually presented as 'Laws of Memory.' There is little to be gained, indeed, by insisting on the greater generality of the laws of association. It is conceivable that impressions might be connected without any consciously apprehended interval between them. Thus it would be hard to say which arose first in the mind, in that indissoluble conjunction, the shape and colour of a body; but a non-serial consciousness, if there be such a thing, is a phenomenon, in the case of man at least, which must be exceedingly limited in its manifestation. It is quite true that we cannot remember our first years, that is, cannot recall events belonging to so early a period; but that the lack of the power of reproduction does not preclude memory, the recognition of a host of objects by infants sufficiently proves.

The capability of remembering implies two things, *retentiveness* and *recognition*, but the former of these terms must be carefully defined or it will be suggestive of error. Strictly speaking, the mind *retains* nothing. What happens, expressed in the language of psychology, is a succession of modes of consciousness recurring from time to time either in the same or in some other order; in physiological language, a number of nervous changes in large part indistinguishable in character from one another. What is past is beyond recall in its original form, what remains is a *disposition*, a lessened power of resistance to similar exciting influences. But this is not all. A repetition of like causes leads to an assimilation or identification of the effects. It is not enough that there be an echo, the echo must reinstate the past, in its truthful outline at least, so that we can say, 'I had a like experience to this on some former occasion. What to me now is idea once was feeling.' The laws of association, then, considered as laws of memory, tell us the way in which these results are obtained, or at least aim at this result, although, as I mentioned at the outset, no explanation is satisfactory which does not take full account of the physical conditions. This being understood, we may now proceed to consider memory exclusively on the subjective side.

A good memory implies speedy reproduction of ideas, a rapid recovery of pictures of scenes formerly witnessed, or a review of conceptions in the order and connection in which they were previously meditated by the mind. It is clear that for the securing of these results the mind must be very impressible in respect of the class of ideas recalled, and that the more numerous the relations of such ideas are the greater will be the likelihood of their being brought within the field of view. As regards the former of these requirements, it may be said that nothing can compensate for considerable obtuseness of faculty. A readiness to be affected by very slight influences is, after all, the supreme condition of memory. Within the same mind, however, there are noticeable the greatest differences in this respect. It is not easy to find a good memory for strongly contrasted orders of facts and truths, a circumstance which must doubtless find its ultimate explanation in the law of the conservation of energy. A good memory may be inferred where the attention is quickly arrested; for this means that the mind will spontaneously recur to the particular class of facts, the aliment offered evidently suiting the constitution.

It is almost saying the same thing in other words when we add that things are most easily remembered where the mind experiences pleasure in cognizing them; for where there is pleasure there is little or no resistance to be overcome, and all the energies are absorbed in the contemplation of the object of interest. Where there is deficient susceptibility we endeavour to make up by repeated impression for the lack of natural fascination. We try to conquer the stubborn intellect by dint of hard and frequent blows. Or the mind is bribed by insinuated pleasure to think on what is naturally indifferent to it. The policy of enforced repetition may be regarded as the discipline of pain, which thus appears in the matter of acquisition to be a hard necessity or secondary resource rather than a primary aid.

Next to the natural susceptibility to impressions the best hope of obtaining a good memory lies in a large store of ideas. The consequence is that the paths to any goal are multiplied, and the chances are increased of clues being found to any forgotten idea of which we are in search. The Principle of Association, usually styled the 'Law of Contiguity,' expresses this condition of memory. It is to the effect that all present states of consciousness tend to drag to the light portions of bygone experience with which their constituents have been connected, either through their having occurred in proximate periods of time or through some special relation of dependence or logical affinity. As in the former case, the firmest cohesions are those which are spontaneously formed, but we may do much to strengthen the contiguous bond by observing certain rules. In early life Nature's tuition is most effective. Sequence alone is then sufficient to form associations; and in most cases the rapidity of acquisition, as illustrated by learning by rote, is truly astounding to the adult mind bereft of such power. It is enough at that early stage that two things occur together, for an indissoluble connection to be forged, and to the very last we are called upon to bless or lament these fortuitous conjunctions. So readily indeed are the links fashioned, that they may elude all control, and there are few who have not cause to regret the tenacity of unbidden associations at some time of their lives. But it cannot be denied that the gain outweighs the disadvantages, and that it would be a mistake to try to discourage this spontaneously associating power. On the other side its direct encouragement requires very considerable judgment; and for that reason it may not be unjustifiably argued that the ablest and wisest teachers are needed for the training of the most youthful minds. The amount of mischief that is done by abusing the great Law of Contiguous Association is incalculable. Some day Society will visit with its sternest reprobation those who abuse their trust to create associations in child-minds which have neither reason nor good principle on their side. It must never be forgotten that it is easier to make than to break an association; and, though man has to a certain extent succeeded in assisting memory, he has not been very successful in framing aids to forgetfulness. But it should not be lost sight of that the latter are almost as much needed as the former. How to forget is often a very serious question; and there would seem no other recipe than this—form fresh associations which may neutralise the

effect of undesirable bonds, and then aid the struggle for existence by continuous concentration on the worthier alliances.

With advancing years more may be safely done in the way of assisting memory than in the earlier period of life. It is usually futile to rely upon the natural plasticity in the hope of producing adhesions by mere time-sequences. 'Learning by heart' is now mostly a waste of time, requiring an effort altogether out of proportion to the value of the result. Resort must now be had to the principles of logic for the cultivation of memory. Memory will be best served by clearness of arrangement, by observing a logical sequence in the course of study, and by relying more on distinctness of conception than on wealth of facts. The mind cannot be supplied with too many facts in the earlier periods; but with the decrease of plastic power, inevitable with increase of years, the materials of knowledge will stand a poor chance of being preserved, unless they are assimilated with previous knowledge and cast in the logical moulds. Hence the importance at this stage of system, of reduction to rule, of deliberate sorting of knowledge. In fact, the other law of Association, which has been called the 'Law of Similarity,' is here the paramount principle, and its importance increases the further the pupil advances on the scientific path. This law affirms that impressions and ideas are associated by resemblance; and the perception of resemblance lies at the root of all the higher qualities of intellect. There is no more powerful aid to memory than the effort to string a number of particular experiences on a common thread, to see that the same principle is illustrated by a host of particulars. Once let the general expression or *law* be comprehended, and the details can be trusted to take care of themselves. All who have been called upon to master a host of details, as in the study of Chemistry, for example, will bear witness how bewildering was the mass of observations and experimental results at first; and the task of remembering all the compositions and decompositions seemed hopeless until substances were arrayed in serial order, and natural alliances were made plain.

In speaking of the deliberate training of the memory, we cannot pass by a question which has been often mooted and answered in very different fashion: whether there be not artificial aids to memory which a thoughtful teacher might find serviceable. In a limited way resort has been had to artificial mnemonics in the shape of doggerel lines for the permanent preservation of some important piece of information which cling to the memory and save the effort of distinct recollection. Mnemonics are sometimes based upon the 'Law of Contiguity,' as in the case of the rhythmical flow of verse which, by the alternate rise and fall of the voice, suggest a continuity that would be lacking in plain prose. In other cases the 'Law of Similarity' is invoked, as in certain aids to the remembering of numbers, by framing a *memoria technica*, which represents numbers by letters, and embeds the latter in some phrase descriptive of the event whose date is to be re-called. Despite the utility of such mnemonics in certain peculiar cases, I apprehend that as a rule purely artificial auxiliaries are undesirable.

The case of numbers is a decided exception, but an exception which justifies the rule. Numbers, as perfect abstractions, can have no natural associations. All numerical changes being rung on ten digits, to expect the human mind to remember more than a very few events by endeavouring to strike up a cohesion between a concrete fact and the permutations of a highly ambiguous set of symbols, is utterly unreasonable. But when we have excepted numbers I do not know that there are any cases where a scientific treatment would justify the systematic employment of mnemonics. Mnemonics are not applied psychology, and applied psychology, one form of which is mental discipline, must be a lawful deduction from the laws of mind. Individuals may, if they please, avail themselves of *memoriæ technicæ*, but the use of such must always remain empirical, and what is a help to one may be a hindrance to another mind. The genuine training of the memory consists in detecting and employing the threads of association which the mind gathers in its spontaneous operation. These methods are necessary, and the art which leans upon them is, what it should be, 'nature better understood.' Exercise strengthens the contiguous bond—perception of cause and effect, and personal experimentation; and the logical laws of the intellect must be obeyed to gain command over groups of facts.

As mental progress of all kinds is dependent upon a good memory, it is evident that the Discipline of the Mind should before all things take care that this fundamental power be strengthened to the utmost, and carefully preserved from deterioration. Nothing is more injurious to real acquisition than to exact from the mind more than its stage of development will justify, or to endeavour to assimilate faster than the nutritive forces permit. It will not be difficult to discover what the right pace of acquisition for any mind really is, if the learner's natural interests be carefully studied. It may be regarded as certain that, where there is great eagerness for any study, a strong memory will be an unfailing accompaniment; our proclivities point out pretty plainly what sort of food we shall most readily assimilate. When the interest is weak and the thoughts easily wander, the cost of acquisition will be considerable, and the wise teacher will be very careful how he endeavours to hasten the pace. The effect may be that the mind is actually thrown back in its course; it is filled with make-believe knowledge, which is retained until it has answered its purpose, say of some 'examination,' and then the seemingly fair fabric of acquired truths vanishes utterly, leaving barrenness and a sense of weariness behind it. Again, when the mind has attained a fair amount of abstract power, nothing is more detrimental to solid acquisition than too extensive reading. How common it is to find men and women who have read everything, and yet know nothing, who have not a general idea within their grasp, their intellectual power having been frittered away in the mere accumulation of facts, or who cannot bring their disorderly knowledge to converge upon any desired point.

We *enfeeble* the memory by trusting too largely to contiguous association, and neglecting logical concatenation. Whoever would have a powerful memory must reflect quite as much as observe. Less stress should also be laid on repetition than on discernment of right relations. A subject is generally more fully mastered by once seeing it in its proper proportions than by any number of re-readings. Nor must we despise the aid of the emotions in the cultivation of memory. If an enthusiasm can be aroused for a subject, there is little doubt that the result will be permanent, but if

the intellect be flogged to its task, if the eye is straying wistfully after some other passionately-desired object, progress will be insignificant.

A pictorial imagination is a good aid to memory, but an ill-balanced constructive imagination is a doubtful ally. By a constructive imagination is meant an imagination that decomposes its experiences and reconstructs them to subserve some particular feeling. Now memory is worthless that is not *faithful*, hence a too exuberant fancy is antithetic to real acquisition. But an imagination which depicts objects to the mind as they really are is an invaluable aid, and may indeed become of supreme importance.

I do not intend hereby to undervalue the constructive imagination, but this is not the place to enlarge upon its part in the intellectual economy. Here the object is to show how the mind may become a mirror of reality, and how the images reflected on it may be saved from permanent destruction. Above all things, therefore, we have to guard against a *confused* memory, which is one of the most unmistakable marks of an ill-trained mind. How difficult it is to obtain a clear and precise narrative of observed events! The narrator not unfrequently intermingles figments of his own unbridled imagination, and mixes up with the fragments of direct perception patches of other days' experiences or ill-grounded inferences. For a just memory, then, we require an habitual self-restraint, a habit of close observation, and an accurate classing of experiences with their allied forerunners. We stumble here upon a truth, of which the student of mind is never long without reminder, viz., how arbitrary are our classifications of the mental powers and functions, for we see plainly that a discussion of memory implicates observation, the imagination, the process of reasoning, even the emotions and the will.

(To be continued.)

Chemistry of the Non-Metallics.

BY EDWARD AVELING, D.SC. LONDON.

[This series of articles, whilst dealing with the subjects required by the University of London for the Matriculation Examination and with those required at the Elementary Stage of the Inorganic Chemistry (Branch X.) Science and Art Department, is intended as a practical guide to the philosophical and systematic study of the non-metallics.]

BAROMETERS.

(1) *Construction and action.*—If a wide, clean glass tube, about 800 mm. long, is filled with mercury, and the

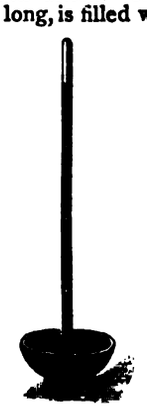

Fig. 7.

open end being temporarily closed by the finger, the tube is inverted, placed with the open end in mercury, and the finger removed, the column of mercury in the tube will descend, until at last it ceases to fall, and remains stationary. It will then be noticed that its height above the level of the mercury in the outside vessel is about 760 mm. Such a tube under such conditions is the simplest form of barometer (Fig. 7). The mercury in the tube is sustained by the pressure of the air. If the pressure of the air increase, the column of mercury will rise. If the pressure of the air, from any cause, diminish at the particular part of the earth where our barometer is situated, the column of mercury in the tube will fall to a greater or less extent. Hence the height of this mercury column is a measure of the pressure or weight of the air at any given time and place. Hence the name of the instrument, βαρος (baros) = weight, μετρον (metron) = measure.

BOYLE'S AND MARIOTTE'S LAW.

A gas placed in any enclosed space diffuses over the whole of such space, no matter how small may be the quantity of gas concerned. If the dimensions of such an enclosed and enclosing space were made to contract, pressure would now be exerted upon the gas, and the volume of the gas would be lessened. To ascertain the exact connection between the volume occupied by gases and the pressure exerted upon them was the object of Boyle and the object of Mariotte. These two observers, working independently, arrived at the same conclusion, that is, the law or verbal expression of an observed order of events is known sometimes as that of Boyle, sometimes as that of Mariotte. At present we are not considering the temperature of the gases studied; that temperature is for the present to be regarded as constant. A bent glass tube is taken with one limb shorter than the other (Fig. 8). The shorter limb is closed, and a

Fig. 8.

Fig. 9.

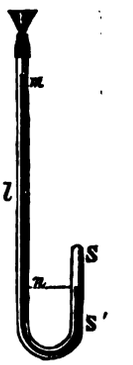

Fig. 10.

funnel is jointed on to the open end of the longer limb by a piece of india-rubber. At present the tube is full of air, and this air is the gas on which the experiment is to be tried. At present also the air that is in the bent tube is under the pressure of the atmosphere outside, as are all bodies at the surface of the earth. Let us assume that the barometer at the time stands at 760 mm., and the air-pressure is equivalent to that exerted by a column of mercury 760 mm. in height. Pour mercury in through the funnel until the bend of the tube is filled, and the air in the short leg is completely shut off from the air in the long leg (Fig. 9). That confined air is the especial portion of gas on which the experiment is to be made. It is still only under the air-pressure equivalent to 760 mm. of mercury, transmitted to it through the mercury in the bend. Its volume under that pressure is the volume of the short limb. Denote this by v.

Under pressure = 760 mm., the gas occupies volume = v. Pour in more mercury *vid* the funnel. The mercury rises more rapidly in the long limb than in the short closed one, as in the latter its inflow is resisted by the imprisoned air. Continue to introduce mercury until the fluid in the short limb is exactly half way up the limb (Fig. 10). The

volume of the air is now exactly half what it was under pressure 760 mm., or is $\frac{v}{2}$. Let us see what pressure it is under. First, there is the old air pressure = 760 mm., still acting and transmitted through all the mass of inpoured mercury. Second, there is the pressure due to that inpoured mercury, but not due to *all* that has been introduced. For the mercury in the bend of the tube exerts no pressure upon the air in the upper part of SS'. Nor does the mercury in the lower part of SS' exert any pressure on the air above it. It cannot press upwards. It is, indeed, pressing downward with its full weight, and would fall were it not for the mercury in the longer limb. Just so much mercury in the long limb as there is of the fluid in the short limb has to support the mercury in SS', and cannot, therefore, press upon the air in SS' at all. What, then, is left to exert weight-pressure upon the enclosed air? The column of mercury from n to m in the long limb, *i.e.*, from a line level with the level of the quicksilver in SS' up to the top of the liquid in l: a column of mercury, in brief, whose height = the difference of level of the fluid in the two limbs. Measuring this difference of level it is found to be 760 mm. Hence the gas, occupying one-half its former volume is found to be under the pressure of (1) the air = 760 mm. of mercury; (2) 760 mm. of mercury.

Under pressure $= 760 \times 2$; the gas occupies volume $= \frac{v}{2}$.

If mercury is poured in until the volume of the air in S is reduced to $\frac{1}{3}$, the difference of level is found to be 1520 mm., or twice 760, and as the air-pressure is still acting and is still transmitted, under pressure $= 760 \times 3$, the gas occupies volume $= \frac{v}{3}$. And, generally, it is established that under pressure of $760 \times n$ the gas occupies volume $= \frac{v}{n}$, *i.e.*, the volume of a gas at constant temperature varies inversely as the pressure upon it. And this is Boyle's and Mariotte's law.

EXAMPLES ON BOYLE'S LAW (*Solved.*)

(18) A Boyle's tube has a short limb, whose contents are 60 cc. What must be the difference of level of mercury in the two tubes that the air may only occupy 25 cc.? Barometer stands at 750 mm.

Given a Boyle's tube with short limb, whose contents = 60 cc., and the barometer standing at 750 mm.

It is required to find the difference of level of mercury in the two limbs if the air occupies 25 cc.

The air occupies 60 cc. under a pressure of 750 mm. mercury.

" " 1 " " $\frac{750 \times 60}{30}$

" " 25 " " $\frac{\cancel{750} \times 60}{\cancel{25}} = 1800$;

∴ the difference of level = 1800 − 750 = <u>1050 mm.</u>

(19) A Boyle's tube has a short limb two decimetres in length. How much mercury must be poured into the tube that the level of that in the closed limb may be two centimetres from the top? Barometer at 768 mm.

Given a Boyle's tube whose short limb has a length of 20 cm., and the barometer standing at 768 mm.

It is required to find how much mercury must be poured in, that the air in the short limb may occupy 2 cm. length.

18 cm. in the short limb are filled with mercury; ∴ 18 cm. are required in the long limb to balance these, and total mercury *not* exerting pressure on air = 36 cm. = 360 mm.

The air occupies 20 cm. under a pressure of 768 mm. mercury.

" " 1 " " 768×20

" " 2 " " $\frac{768 \times 20}{2} = 7680$

Total mercury required = 7680 − 768 + 360 = <u>7272 mm.</u>

(20) Into a Boyle's tube, whose short limb = 3 centimetres in length and is 1 square millimetre in section, water is poured until the air only occupies 10 millimetres of the short limb. What weight of water has been introduced? Barometer at 760 millimetres.

Given a Boyle's tube, whose short limb = 30 mm., into which water is poured until the air only occupies 10 mm.

It is required to find what weight of water has been introduced.

20 + 20 mm. of water are required to balance each other = 40 mm.

Air occupies 30 mm. under pressure of 760 mm. mercury.

" " 1 " " " " $\frac{760 \times 30}{3}$

" " 10 " " " " $\frac{760 \times \cancel{30}}{\cancel{10}} = 2280$.

But a pressure = 760 mm. mercury is due to the atmosphere, and is merely transmitted, ∴ 2280 − 760 = 1520 mm. is the amount of mercury required. The specific gravity of mercury = 13·5; ∴ 1520 × 13·5 = 20520 mm. water are required.

Total amount = 40 + 20520 = 20560 cubic mm.

Now the *weight* of water is required.

1 cubic centimetre = 1 gram.,

20560 cubic mm. = $\frac{20560}{1000}$ cubic centimetres weighing <u>20·56 grams.</u>

(20*a*) Find the length of the short limb of a Boyle's tube, if, after altogether 243 cm. length of mercury have been poured in, the air in the short limb occupies $2\frac{1}{2}$ cm.

Let x represent the length of the mercury column in the short limb.

∴ $(x+25)$ mm. represents the length of limb.

Under pressure 760 mm. vol. $= x+25$

1 " " $= (x+25) \times 760$

" " 760 " (due to air) + $(2430 - 2x)$, due to difference of level of mercury $= \frac{(x+25) \times 760}{760 + 2430 - 2x}$

But vol. = 25 mm.

$$\therefore \frac{760\,(x+25)}{3190 - 2x} = 25 \quad \therefore \frac{152\,(x+25)}{3190 - 2x} = 5$$

$$\therefore 152x + 3800 = 15950 - 10x$$

$$\therefore 162x = 12150$$

$$81x = 6075$$

$$9x = 675$$

$$x = 75.$$

∴ length = 75 + 25 = 100 mm. = <u>1 decim.</u>

(21) 10 litres of gas are measured off at a pressure = 800 mm. of mercury. What volume will they occupy under normal pressure?

Given that 10 litres of gas are measured under 800 mm.

It is required to find what volume they occupy under normal pressure.

Normal pressure = 760 mm. mercury.

Under a pressure of 800 mm. the gas has a volume of 10 litres.

" " 1 " " " " 10×800 "

" " 760 " " " " $\frac{10 \times 800}{760}$

$= \frac{8000}{760} = 10{\cdot}526$ <u>litres.</u>

(22) To what additional pressure must 1 litre of gas under 760 mm. be subjected to reduce its volume to 3 decilitres?

Given that 1 litre of gas under 760 mm. is reduced to 3 decilitres.

It is required to find the pressure.

3 decilitres = $\frac{3}{10}$ litre.

Volume of gas is 10 decilitres under pressure of 760 mm.

" " 1 " " " " 760×10

" " 3 " " " " $\frac{760 \times 10}{3}$

$= \frac{7600}{3} = 2533{\cdot}3$

∴ the additional pressure is 2533·3 − 760 = <u>1773·3 mm.</u>

(23) 5 litres of gas are measured over water, and the level of the water outside is 405 mm. higher than the level of the water inside the gas-jar. What would be the volume of the gas under normal pressure? Barometer at 770. Specific gravity of mercury, 13·5.

Given that 5 litres of gas are measured over water, and that the water outside exerts a pressure = weight of column of water 405 mm. high, the barometer standing at 770 mm.

It is required to find the volume of the gas, under pressure = 760 mm. mercury.

The gas is under a pressure of 770 mm. due to the atmosphere, and $\frac{405}{13{\cdot}5} = 30$ mm. mercury; total 800 mm. mercury.

Under pressure 800, volume of gas is 5 litres.

" " 1 " " " " 5×800

" " 760 " " " " $\frac{5 \times 800}{760} = \frac{5 \times 20}{19}$

$= \frac{100}{19} = 5\frac{5}{19}$ <u>mm.</u>

(*To be continued.*)

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ANSWERS TO
Pupil Teachers' Examination Papers.
MAY 31ST, 1884.
FIRST YEAR.
Pupil Teachers at end of First Year.

Three hours and a half allowed.

Arithmetic.

MALES.

1. Reduce to a fraction $\frac{1}{3}+\frac{9}{16}$ of $\frac{3}{16}+\frac{\cdot0375}{6\cdot25}$; and find the value of $\cdot0324\times\cdot085\div4\cdot86$.

$\frac{1}{3}+\frac{9}{16}$ of $\frac{3}{16}+\frac{\cdot0375}{6\cdot25}$
$=\frac{1}{3}+(\frac{9}{16}\times\frac{3}{16})+(\frac{375}{10000}\times\frac{100}{625})$
$=\frac{1}{3}+\frac{27}{256}+\frac{3}{160}$
$=\frac{500+180+9}{1500}$
$=\frac{689}{1500}$. Ans.

$$\begin{array}{r} \cdot0324 \\ \cdot085 \\ \hline 1620 \\ 2592 \\ \hline 4\cdot86)\cdot002754000(\cdot00056 \text{. Ans.} \\ 2430 \\ \hline 3240 \\ 2916 \\ \hline 324 \end{array}$$

2. Find the value in money of 2·0175 of £6 5s. + ·3125 of half a guinea − ·083 of 2½d.

	£	£	s.	d.
2·0175 of £6 5s. = 2·0175 × 6·25 =		12	12	2½
·3125 of half a guinea = ·3125 × 10·5 =		0	3	3⅜
		12	15	5⅜
·083 of 2½d. = $\frac{83}{1000}\times\frac{5}{2}$d. =		0	0	$0\frac{415}{1000}$
		12	15	$5\frac{415}{1000}$. Ans.

3. Give a rule for finding the decimal point in dividing one decimal by another, and illustrate your rule by dividing ·675 by ·000625.

Rule.—Subtract the no. of decimal places in the divisor from the no. in the dividend, and mark off the difference in the quotient.

If the no. in the dividend is less than the no. in the divisor, 0's must be added and brought down, till the subtraction can be made.

$$\begin{array}{r} \cdot000625)\cdot675000(1080 \text{. Ans.} \\ 625 \\ \hline 5000 \\ 5000 \\ \hline 0 \end{array}$$

4. A man after selling $\frac{3}{5}$ of $\frac{7}{16}$ of his share in a ship finds that he owns $\frac{8}{15}$ of the ship. What part of it did he own at first?

$\frac{3}{5}$ of $\frac{7}{16}$ = $\frac{21}{160}$ of share sold.
$1-\frac{21}{160}=\frac{139}{160}$,, kept.
$\frac{139}{160}:1::\frac{8}{15}:\frac{128}{1197}$. Ans.

FEMALES.

1. What will be the cost of 3 lbs. 9 ozs. 17 dwts. 12 grs. at 20 guineas per lb.?

	£	s.	d.		
6 ozs. = ½ lb.	21	0	0	= Cost of 1 lb.	
		3			
	63	0	0	= ,,	3 lbs.
3 ozs. = ½ of 6 ozs.	10	10	0	= ,,	6 ozs.
10 dwts. = ⅓ of 3 ozs.	5	5	0	= ,,	3 ozs.
5 dwts. = ½ of 10 dwts.	0	17	6	= ,,	10 dwts.
2 dwts. = ⅖ of 10 dwts.	0	8	9	= ,,	5 dwts.
12 grs. = ⅙ of 2 dwts.	0	3	6	= ,,	2 dwts.
	0	0	10½	= ,,	12 grs.
	£80	5	7½	= ,,	3 lbs. 9 ozs. 17 dwts. 12 grs. Ans.

2. Add together $103\frac{11}{12}$, $1\frac{5}{8}$, $204\frac{11}{16}$, and $2\frac{1}{3}$.

$103\frac{11}{12}+1\frac{5}{8}+204\frac{11}{16}+2\frac{1}{3}$
$=310\frac{44+30+33+16}{48}$
$=310\frac{123}{48}$
$=312\frac{27}{48}$
$=312\frac{9}{16}$. Ans.

3. Find the number of miles in the radius of the earth, having given that it is the least number which is divisible by 2, 3, 4, 5, 6, 8, 9, 10, 11, and 12.

The least No. divisible by these Nos. is their L.C.M.

2	2, 3, 4, 5, 6, 8, 9, 10, 11, 12
3	4, 9, 5, 11, 6
	4, 3, 5, 11, 2

L.C.M. = 2 × 3 × 4 × 3 × 5 × 11 = 3960. Ans.

4. Make out the following bill:

7 doz. and 4 eggs at 9d. a dozen.
19 lbs. of soap at 5½d. per lb.
18 lbs. of butter at 1s. 2d. per lb.
13¾ lbs. of cheese at 7½d. per lb.
8 four-lb. loaves at 4½d. each.
½ lb. of pepper at 1½d. per oz.

11, Market Street, Manchester,
31st May, 1884.

Mrs. Granger,

Bought of Henry Field.

	£	s.	d.
7 doz. and 4 eggs at 9d. a doz.	0	5	6
19 lbs. of soap at 5½d. per lb.	0	8	8½
18 lbs. of butter at 1s. 2d. per lb.	1	1	0
13¾ lbs. of cheese at 7½d. per lb.	0	8	5½
8 four-lb. loaves at 4½d. each	0	3	0
½ lb. pepper at 1½d. per oz.	0	0	10
	£2	7	5½

Grammar.

MALES AND FEMALES.

1. ' Cowards die many times before their death.
The valiant only taste of death but once.—
SHAKESPEARE.

Analyse these lines and parse them.

2. Point out any *English* terminations in them; and give instances of words with a similar ending.

Sentence.	Kind of Sentence.	Subject.	Predicate.	Object.	Extension.
(*a*) Cowards die many times before their death,	P.S.	Cowards	die		many times before their death (time)
(*b*) The valiant only taste of death but once.	P.S.	The valiant only	taste	of death (Ins.)	but once (time)

Cowards—noun, com., masc., plu., 3rd, nom. to 'die.'
die—verb, reg. intrans., act., ind., pres., 3rd, plu., agreeing with its nom. 'cowards.'
many—adj., indef. numl., qualifying 'times.'
times—noun, abs., neut., plu., 3rd, obj. of time to 'die.'
many times—advl. phrase (time), qualifying 'die.'
before—prep., showing the relation between 'death' and 'die.'
their—per. pro., masc., plu., 3rd, poss., gov. by 'death.'
death—noun, abs., neut., sing., 3rd, obj., gov. by 'before.'
the—adj. of distinction, pointing out 'valiant.'
valiant—adj., used as com. noun, masc., plu., 3rd, nom. to 'taste.'
only—adj. of quality, qual. 'valiant.'
taste—verb, reg. intrans.. act., ind., pres , 3rd, plu., agreeing with its nom. 'valiant.'
of—prep., showing relation between 'death' and 'taste.'
death—noun, abs., neut., sing., obj., gov. by 'of.'
but—adv. of deg., qual. 'once.'
once—adv. of time., qual. 'taste.'

2. *-ard* in *cowards;* drunkard, laggard, dastard.
-th in *death* (from die); mirth, earth, berth, length.
-y in *many;* wealthy, mighty, any, dreary.
-ce in *once;* hence, thence, whence.
-ly in *only;* badly, purely, wilfully.

3. What is meant by 'Mood,' and how many 'Moods' are there? Write out the Imperative Mood of the verb 'to die.'

Mood is the inflexion which a verb undergoes to show the mood or manner in which the action is presented to the mind.
Some grammarians say *five*, others *four*.
By the first the *Potential* is considered a mood, by the latter the auxiliaries which are said to form the Potential Mood are treated as auxiliaries of the Indicative and Subjunctive Moods.

To die.
Imperative Mood.

Singular.	*Present Tense.*	*Plural.*
2. *Die* (thou.)		2. *Die* (ye or you.)

Geography.

1. Draw a full map of Northumberland, Durham, and Yorkshire.

N.B.—Insert the lines of latitude and longitude.

2. Describe, as for children, the formation of springs and the course of a river; showing how and why it widens and deepens as it goes on, and explaining the geographical terms which are applied to it. Illustrate by examples.

Snow and rain fall on the hills and mountains. Some of the rain runs down the slopes. Little rills from all the hollows between the hills join together and form a stream. Some of the rain and the melted snow find their way into the ground. This water sinks till it comes to a hard rock or bed of clay, through which it cannot pass. It gathers into a great mass, till at last it forces its way through some crack or crevice to the surface of the ground. Here it bubbles up and forms a spring. (Draw diagram on blackboard.) The water overflows, and joining the rills, or being joined by them, makes the stream. The place where the river rises is called its *source*, and the little rills which feed the stream by flowing into it are called *feeders*, *tributaries*, or *affluents*. Where one of these joins the larger stream is called the *confluence*. The hollow worn out by the water is called the *bed;* the land on either side, the *banks;* the whole country drained by the river, the *basin;* and the place where it joins the sea, the *mouth*. If the water divides as it nears the sea, the land between the mouths is called *a delta*. (Show on map or draw on blackboard a map of any river, say the *Thames*. Point to Cotswold Hills, Kennet, Wey, Mole, etc., and the estuary.)

3. Describe the position and character of Quebec, Montreal, Ottawa, Winnipeg, St. John's, and Halifax.

Quebec, on a bold rocky plateau on the north bank of the St. Lawrence, about 340 miles from its mouth. It is strongly fortified, and has great trade. Capital of Quebec province.
Montreal, on the S.E. side of the island of the same name, near the confluence of the Ottawa and the St. Lawrence, in the province of Quebec. It is the largest town of the dominion.
Ottawa, capital of the dominion of Canada, at the junction of the Rideau Canal and the Ottawa river. Has a population of 25,000.
Winnipeg, capital of the province of Manitoba, about forty miles south of Lake Winnipeg, and on the Red River. A seat of the fur, lumber, and grain trade.
St. John's, on the S.E. coast of Newfoundland, of which it is the capital. Strongly fortified, and engaged in fisheries.
Halifax, on the S.E. coast of Nova Scotia, of which it is the capital. It has a splendid harbour, which is the chief British naval station in America.

History.

1. In the time of Alfred three different nations occupied this country; tell who they were, and in what districts they were severally found.

The three different nations occupying this country in the time of Alfred were the Ancient Britons, the Saxons, and the Danes.
The Britons occupied Wales, Cornwall, and part of Devon, Cumberland, Westmoreland, and Lancashire.
The Saxons occupied the south, south-east, and centre of the country.
The Danes were possessed of East Anglia and Northumbria, stretching as far inland as Watling Street.

2. With what letter do the names of most of our Saxon kings begin? Write down at least five such names and give the dates of their reigns.

The letter *E*.

	A.D.
Egbert	827—836
Ethelwulph...	836—857
Ethelbald	858—860
Ethelbert	860—866
Ethelred	866—871
Edmund	941—946
Edred	946—955
Edwy	955—959
Edgar	959—975
Edward	975—979
etc.	

3. What were the distinguishing ranks of society in the tenth century? Describe their condition.

The principal person in the kingdom was the King, elected to that office by the Great Council. After the king came, the Eldermen, or Earls, who ruled their districts called shires, and led their armies to battle on behalf of their king and country. Then came the lower nobles, called Thanes, owning at least five hides of land. Ceorls were the last class of freemen, and the burghers of the towns were engaged in trade. Two-thirds of the people were in a state of great degradation amounting to slavery. Sale and purchase of men were quite common. The people lived on the lands of their lord, and were not allowed to remove without permission. The life of all the Anglo-Saxons would now be considered savage, and there were none of the refinements of the present day, either in home, or dress, or food.

Composition.

Write from memory the substance of the passage read to you by the Inspector.

There is a story told of Saint Anselm, that he was out riding one day, after he had become Archbishop of Canterbury, when the young men of his train started and chased a hare with their dogs. The hare took refuge under Anselm's horse. Anselm reined in his horse; the young men crowded round with noisy triumph at the capture, but Anselm forbade them to touch the hare. 'You laugh,' he said, 'but for the poor creature there is nothing to laugh at; its mortal foes are about it, and it flies to us, beseeching for shelter. It is an image of the departing soul of man, hunted by its enemies the evil spirits.' Then he rode on, and with a loud voice forbade both men and dogs to pursue the hare; and the creature, glad and at liberty, darted off to the fields and woods.

Needlework.

FEMALES.

One hour will be allowed for this exercise in the afternoon.

Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write above each of the following notes its value-name (semibreve, &c.), and below each its pitch-name.

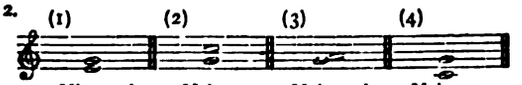
1. (1) (2) (3) (4) (5)

Minim. Quaver. Semibreve. Crotchet. Semiquaver.

C or Do. D or Re. G or Sol. A or La. C or Do.

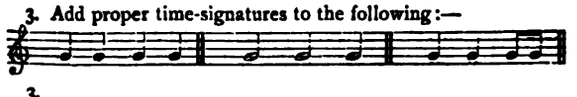
2. Write below each of the following intervals its name (major third, &c.):—

2. (1) (2) (3) (4)

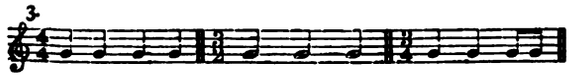


Minor 3rd. Major or Perfect 4th. Major 2nd. Major or Perfect 5th.

3. Add proper time-signatures to the following:—



3.



TONIC SOL-FA NOTATION.

1. Write a six-pulse tone, using two-pulse measures.

1. |d :— |— :— |— :— ‖

2. Write the names of the following intervals:—(1) *me* to *soh*; (2) *soh* to *doh'*; (3) *soh* to *lah*; (4) *doh* to *soh*.

2. (1) Minor 3rd; (2) Major or Perfect 4th; (3) Major 2nd; (4) Major or Perfect 5th.

3. Write the following an octave higher:—

m, d, m, s, l, t, d

3. m d m s l t d'

SECOND YEAR.

Pupil Teachers at end of Second Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

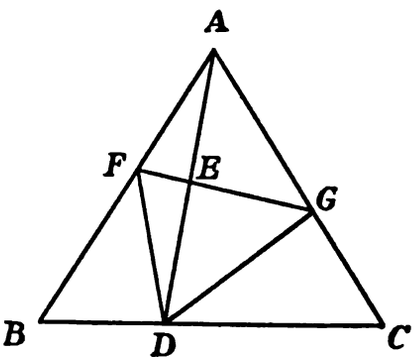
1. If two triangles have two sides of the one equal to two sides of the other, each to each, and have likewise the angles contained by those sides equal to each other; they shall likewise have their bases or third sides equal, and the two triangles shall be equal, and their other angles shall be equal, each to each, viz., those to which the equal sides are opposite.

Euclid, Book I., Prop. 4.

2. If two triangles have two sides of the one equal to two sides of the other, each to each, but the base of one greater than the base of the other; the angle contained by the sides of the one which has the greater base, shall be greater than the angle contained by the sides, equal to them, of the other.

Euclid, Book I., Prop. 25.

3. In the base BC of a triangle ABC any point D is taken. Draw a straight line such that if the triangle ABC be folded about this straight line, the point A shall fall on the point D.



In the given triangle ABC, join AD, and bisect AD in E. Through E draw FG at right ∠s to AD, meeting AB and AC in F and G. FG is the line required.

Join FD, GD.

Because in the two △s DEF, AEF, DE=AE (Const.) and EF is common, the two sides DE, EF=two sides AE, EF, each to each; and the ∠AEF=∠DEF (Const.), ∴ base DF=base AF; and ∠FAE=∠FDE (I. 4.)

In like manner it may be shown that AG=GD and ∠GAE=∠GDE.

∴ whole ∠GAF=whole ∠GDF.

Wherefore if the △ AFG be folded about the line FG, it will coincide with the △ FDG, and the point A will coincide with the point E (I. 4.) Q. E. F.

Arithmetic.

FEMALES.

1. To the sum of $2\frac{1}{2}$ and $3\frac{3}{4}$ add the difference between $4\frac{3}{4}$ and $5\frac{1}{4}$, and multiply the result by the quotient of $7\frac{1}{7}$ divided by $6\frac{1}{2}$.

$$(2\tfrac{1}{2}+3\tfrac{3}{4})+(5\tfrac{1}{4}-4\tfrac{3}{4})\times(7\tfrac{1}{7}\div 6\tfrac{1}{2})$$
$$=\left(5\frac{3+4}{6}\right)+\left(1\frac{16-15}{20}\right)\times\left(\tfrac{50}{7}\times\tfrac{2}{11}\right)$$
$$=(6\tfrac{1}{2}+1\tfrac{1}{20})\times\tfrac{100}{77}$$
$$=7\frac{10+3}{60}\times\frac{100}{77}$$
$$=\tfrac{433}{60}\times\tfrac{100}{77}$$
$$=8\tfrac{113}{231}. \text{ Ans.}$$

2. Express as decimals $\frac{3}{1000}$ and $\frac{33}{100}$.

$$=\frac{3}{1000}=\text{·003} \qquad =\frac{33}{100}=\frac{2\text{·}3}{16}$$

$$=\text{·000375. Ans.} \qquad =\text{·}14375\text{. Ans.}$$

3. Find the difference between $1\frac{3}{4}$ of £1 13s. 9d., and $\frac{3}{7}$ of £5 18s. 5d., and reduce the result to the fraction of a guinea.

$$\frac{1\frac{3}{4} \text{ of } £1\ 13s.\ 9d. - \frac{3}{7} \text{ of } £5\ 18s.\ 5d.}{1 \text{ guinea}}$$
$$= \frac{\frac{7}{4} \times \frac{459}{4} - \frac{3}{7} \times \frac{1421}{4}}{252}$$
$$= \frac{675 - 609}{252}$$
$$= \frac{11}{42}. \text{ Ans.}$$

4. Find the cost of carpeting a room 34 ft. 9 in. long, by 26 ft. 6 in. wide, at 4s. 6d. per sq. yd.

$$(34\frac{3}{4} \times 26\frac{1}{2} \div 9) \times 4\frac{1}{2}\text{s.}$$
$$= \frac{139}{4} \times \frac{53}{2} \times \frac{1}{9} \times \frac{9}{2}$$
$$= \frac{7367}{16}$$
$$= £23\ 0s.\ 5\frac{1}{4}\text{d. Ans.}$$

Grammar.

MALES AND FEMALES.

1. Immortal *glories* in my mind *revive*,
And in my soul *a thousand passions strive*,
When Rome's *exalted beauties* I *descry*,
Magnificent in piles of ruin *lie*. ADDISON.

Analyse the above, parsing the words in italics.

2. Point out any Latin prefixes in the above, and give their meanings; and instance other words in which they occur.

ANALYSIS.

Sentence.	Kind of Sent.	Connective.	Subject.	Pred.	Object.	Extension.
(*a*) Immortal glories in my mind revive	Princ. Sent.		Immortal glories	revive		in my mind (*place*)
(*b*) and in my soul a thousand passions strive	Princ. coord. with (*a*)	and	a thousand passions	strive		in my soul (*place*)
(*c*) When Rome's exalted beauties I descry, magnificent in piles of ruin lie	Adv. S. (time) to (*a*) and (*b*)	when	I	descry	Rome's exalted beauties m'gnific'nt in piles of ruin lie.	

PARSING.

Glories—noun, abs., neut., plur., 3rd, nom. to 'revive.'
revive—verb, reg. intrans., act., ind., pres., plur, 3rd, agreeing with 'glories.'
a—adj. of distinction, limiting 'thousand.'
thousand—adj. of number, qualg. 'passions.'
a thousand—comp. adj., qualg. 'passions.'
passions—noun, abs., plur., neut., 3rd, nom. to 'strive.'
strive—verb, irreg. intrans., act., pres., plur., 3rd, agreeing with 'passions.'
when—advl. conj., joining 'glories revive' and 'I descry.'
exalted—partl. adj. of quality, qualg. 'beauties.'
beauties—noun, com., neut., plur., 3rd, obj., gov. by 'descry.'
descry—verb, reg. trans., act., ind., pres., 1st, sing., agreeing with 'I.'
magnificent—adj. of quality, qualg. 'beauties.'
lie—verb, irreg. intrans., act., inf., pres., gov. by 'descry.'

3. Paraphrase the following:—

He that holds fast the golden mean,
And lives contentedly between
The little and the great,
Feels not the wants that pinch the poor,
Nor plagues that haunt the rich man's door,
Imbittering all his state.

The man who is wise enough to be perfectly contented with a medium position in life, without aspiring to be great or fearing to be little, is preserved from feeling the pangs of hunger and the sore needs of the poor; while he is also free from the petty annoyances which continually surround the home and mar the happiness of the rich.

Geography.

(Answer Two Questions.)

1. Draw a map, showing the coast-line of the Baltic Sea, and full physical features of Norway and Sweden.
N.B.—Insert the lines of latitude and longitude.

2. What causes affect climate? Give illustrations from the different British possessions.
Among the principal causes which affect climate are:—
(*a*) *Nearness to the Equator.*—Countries near are hotter than those more remote; thus India is hotter than Cape Colony, and Cape Colony than Canada.
(*b*) *Proximity to the sea.*—The sea moderates the climate; lands near the sea are moister and more temperate than those inland; thus British Columbia has more rain and is milder than Quebec.
(*c*) *Elevation.*—Mountainous countries are colder than flat, low-lying countries. Europeans go to the hills during the hot season in India to escape the heat of the plains.
(*d*) *Direction of the mountain-chains, and general slope of the country.*—Mountain-chains may be so placed as to moderate the climate whether as regards heat or cold, as the Himalayas do in India.
(*e*) *Cultivation, character of the soil, etc.*—Presence of trees alter the amount of moisture. Where planted, as in Cape Colony, or some districts of Australia, the climate is more moist.

3. Describe fully the basin of the Ganges.
The basin of the Ganges embraces an area of nearly 400,000 square miles, and extends from the Himalayas in the north to the Vindhyas in the south, and from the high lands separating it from the basin of the Indus in the west to the Bay of Bengal in the east. The river rises in the Himalayas at a height of 11,000 feet, and flows through the range for a distance of two hundred miles. On entering the great plain it is not more than 1000 feet above the level of the sea, and the basin is thus remarkably flat for nearly 1300 miles. The basin includes numerous tributaries to the main stream, among others being the Jumna from the Himalayas and the Sone from the Vindhyas on the right bank, and the Goomtee, Gunduck, and Godra, on the left, are from the Himalayas.
At a considerable distance from the sea the river forms many mouths, and receives the Brahmapootra, the lower course of which is thus included in the Ganges basin, which is very fertile, and covered with a vast population in large cities and towns, Calcutta, Delhi, Benares, Patna, and Allahabad, being the chief.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination papers.

Arithmetic.

MALES.

1. If I get £5 12s. 6d. for the loan of £375 for 4 months, what rate per cent. per annum of interest do I get?

$$\text{Rate for } £375 \text{ for 4 mos.} = 5\tfrac{5}{8}$$
$$\text{,, } \quad 1 \text{ ,, } 1 \text{ ,, } = \frac{5\frac{5}{8}}{375 \times 4}$$
$$\text{,, } \quad 100 \text{ ,, } 12 \text{ ,, } = \frac{5\frac{5}{8} \times 100 \times 12}{375 \times 4}$$
$$= 4\tfrac{1}{2}\text{. Ans.}$$

2. If I invest £2925 in railway stock at $97\frac{1}{2}$, what would I lose in capital if the stock fell to $95\frac{3}{4}$? (Omit brokerage.)

$$97\tfrac{1}{2} - 95\tfrac{3}{4} = 1\tfrac{3}{4}$$
$$\text{Loss on } £97\tfrac{1}{2} = 1\tfrac{3}{4}$$
$$\text{,, } \quad 1 = \frac{1\frac{3}{4}}{97\frac{1}{2}}$$
$$\text{,, } \quad 2925 = \frac{1\frac{3}{4} \times 2925}{97\frac{1}{2}}$$
$$= £52\ 10s. \text{ Ans.}$$

3. A merchant has four ships, the 1st of which brings him a profit of £1200 in 10 months, the 2nd £1500 in 12 months, the 3rd £700 in 9 months, and the 4th a loss of £500 in 8 months. Find his average gain per month.

Profit per mo. on 1st = $\frac{1}{12}$ of £1440 = £120
" 2nd = $\frac{1}{12}$ of £1500 = 125
" 3rd = $\frac{1}{12}$ of £924 = 77$\frac{1}{2}$
Total gain = 322$\frac{1}{2}$
Loss per mo. on 4th. = $\frac{1}{24}$ of £1500 = 62$\frac{1}{2}$
£260 Ans.

4. If the true discount on a bill of £387 10s. be £12 10s., interest being at 5 per cent. per annum, in how many months will the bill be due?

Present worth = £387 10s. − £12 10s. = £375.
Int. on £375 for 1 year at 5 per cent. = £18 15s.
£ s. £ s. mos. mos.
18 15 : 12 10 :: 12 : 8. Ans.

History.

MALES AND FEMALES.

1. Under the feudal system what were the chief advantages claimed by the lord?

(*a*) He claimed *homage* from the vassal, who swore *fealty* to his lord, and assisted him against his enemies.
(*b*) Also *aids* on special occasions.
(*c*) *Reliefs* or payments made by vassals on succeeding to the estates of their predecessors.
(*d*) He had the power to give wards in marriage.
(*e*) He exacted *fines* when land was alienated.
(*f*) He *escheated* the property when the vassal left no heirs.

2. When and for how long did Richard II. reign? Tell the names and nationality of his wives, and compare his character with that of his father.

Richard II. reigned from 1377 to 1399. He married (1) Anne of Bohemia; (2) Isabella of France. Richard had some ability, but was of a violent temper and deficient in judgment, both qualities rendering him unfit to reign. When he did assert his will his conduct became tyrannical. On the other hand, the Black Prince, his father, was of a brave, prudent, active, and warlike disposition. When he died he had the reputation of possessing all the virtues of perfect chivalry, although the latter part of his life was marred by some instances of cruelty.

3. When did Cade's insurrection occur, and what complaints were then made by the people?

In the reign of Henry VI., 1450. The people of Kent whom he led complained that it was rumoured Kent was to be desolated because of Suffolk's death, that prosperity was driven from the land by misgovernment, that the people were not paid for stuff taken for the King's use, that places of trust were filled by mean and corrupt persons, that they had been greatly overtaxed, that the sheriffs were guilty of extortion, and that they had not been allowed freely to elect Members of Parliament.

Teaching.

What common mispronunciations are to be found in your district, and how would you correct them in a reading lesson?

Note.—The answers to this question would be very varied, according to the districts in which the examinations were held. The following is an example for one district only.

The principal mispronunciations in this district are of words in which the letter *r* occurs, words like length and strength, the *g* being left out, words ending in *-een* and *-eing* being similarly pronounced, and words in *-ealm* being made into two syllables.

To correct the first, practice is given with an exaggerated sound of the letter in pronouncing the syllables *ar, er, ir, or, ur;* the position of the tongue is shown, and all words are spoken slowly. With the letter *g* the words are divided into two sounds, the *leng* being said first and the sound of *-th* added. In *been* and *being* the hard sound of the *g* is made prominent till the distinction is seen. Practice in slow pronunciation and imitation of the teacher's pattern voice and formation of mouth correct the latter.

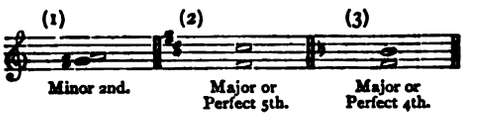
Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

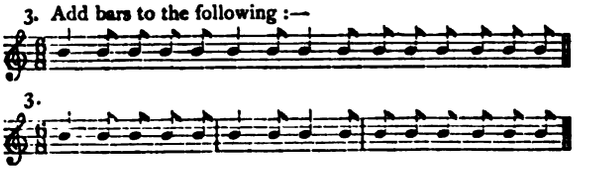
1. Write below each of the following intervals its name (minor third, &c.):—

1.



2. Write the scale of A major, placing the necessary sharps before the notes to be sharpened.

2.

3. Add bars to the following:—

TONIC SOL-FA NOTATION.

1. What is the interval (major third, &c.) (1) between *te* and *doh*^{1}; (2) between *me* and *te*; (3) between *doh* and *fah*?

1. (1) Minor 2nd; (2) Major or Perfect 5th; (3) Major or Perfect 4th.

2. What is the mental effect (1) of *me*? (2) of *soh*?

2. (1) Steady, calm, placid; (2) grand, bold, and bright.

3. Write (1) the pulse signs for a four-pulse measure; (2) a six-pulse measure.

3. (1) | : | : ‖ (2) | : : | : : ‖

THIRD YEAR.

Pupil Teachers at end of Third Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including No. 3, if you can.

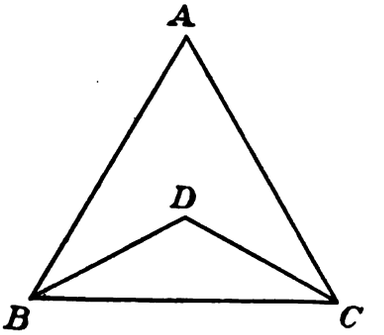
1. Straight lines which are parallel to the same straight line are parallel to each other.

Euclid, Book I., Prop. 30.

2. If a parallelogram and a triangle be upon the same base, and between the same parallels; the parallelogram shall be double of the triangle.

Euclid, Book I., Prop. 41.

3. Construct a triangle having the vertical angle four times each of the angles at the base.



Describe an equilateral triangle ABC (I. 1.) Bisect each of he ∠'s ABC, ACB by BD, CD meeting in D (I. 9.)

Then Δ DBC shall have its vertical $\angle$ double of each of the $\angle$'s DBC, DCB.

Since every equilateral Δ is equiangular (Cor. I. 5), and the three $\angle$'s of every Δ = two right $\angle$'s;

$\therefore$ each of the $\angle$'s of Δ ABC = $\frac{1}{3}$rd of two right $\angle$'s;

$\therefore$ also DBC, DCB each = $\frac{1}{2}$th of two right $\angle$'s, and together they = $\frac{1}{3}$rd of two right $\angle$'s;

$\therefore$ remg. $\angle$ BDC of Δ DBC = $\frac{2}{3}$rds, or $\frac{4}{6}$ths of two right $\angle$'s.

i.e. the $\angle$ BDC = four times each of the $\angle$'s DBC, DCB.

Q. E. F.

Algebra.

(*Answer two Questions, including Question 2, if you can.*)

1. If $a=3$, $b=4$, $c=5$, $d=6$, find the numerical value of—

$$\frac{(a+b)(c+d)-(b+c)(d+a)}{ab-bc+cd-da}$$

and also of $\dfrac{2\sqrt{a^2+b^2}+\sqrt[3]{a^3+b^3+c^3}}{d-c+b-a}$

(*a*)
$$\frac{(a+b)(c+d)-(b+c)(d+a)}{ab-bc+cd-da}$$
$$=\frac{(3+4)(5+6)-(4+5)(6+3)}{12-20+30-18}$$
$$=\frac{77-81}{42-38}$$
$$=\frac{-4}{4}$$
$$=\underline{-1.}\ \text{Ans.}$$

(*b*)
$$\frac{2\sqrt{a^2+b^2}+\sqrt[3]{a^3+b^3+c^3}}{d-c+b-a}$$
$$=\frac{2\sqrt{9+16}+\sqrt[3]{27+64+125}}{6-5+4-3}$$
$$=\frac{10+6}{2}$$
$$=\underline{8.}\ \text{Ans.}$$

2. State and prove the rule for finding the L.C.M. of two expressions, and find the L.C.M. of $9x^3-x-2$ and $3x^3-10x^2-7x-4$.

Rule.—Divide one of the expressions by their G.C.M. Then multiply the quotient and the other expression together; the product will be the L.C.M., or—

Divide each of the expressions by the G.C.M. Then mult. the quotients and the G.C.M. for the L.C.M.

If two numbers are prime to each other, the only no. which will contain them is their product. But if two nos. have a common factor, then the least no. which will contain them both must contain not only those parts of them which are prime to each other but their G.C.M.

For let $a=cx$ and $b=cy$. Then x and y are prime to each other, and c is common, and the least multiple to contain cx and cy is cxy. But c is the G.C.M. of a and b, and x and y are the parts prime to each other.

And $cxy=ay=bx=\dfrac{ab}{c}$.

$3x^3-10x^2-7x-4)9x^3-x-2\ (3$
$9x^3-30x^2-21x-12$
$10)30x^2+20x+10$
$3x^2+2x+1)3x^3-10x^2-7x-4(x-4$
$3x^3+2x^2+x$
$-12x^2-8x-4$
$-12x^2-8x-4$

G.C.M. $=3x^2+2x+1$

$3x^2+2x+1)3x^3-10x^2-7x-4,\ 9x^3-x-2$

$x-4,\ 3x-2$

L.C.M. $=(3x^2+2x+1)(x-4)(3x-2)$
$=(9x^2-x-2)(x-4)$
$=\underline{9x^4-36x^3-x^2+2x+8.}$ Ans.

3. A farmer sold to one person six more than one fourth of his sheep, to another one fifth of the remainder, and to a third two more than one sixth of those now left. If he has still eighteen unsold, how many had he at first?

Let x = No. he had at first,

then $\frac{x}{4}+6$ = No. in first sale,

and $\frac{3}{4}x-6$ = No. after first sale

then $\frac{1}{5}(\frac{3}{4}x-6)$ = No. in second sale

and $\frac{4}{5}(\frac{3}{4}x-6)$ = No. after second sale

then $\frac{1}{6}$ of $\frac{4}{5}(\frac{3}{4}x-6)+2$ = No. in third sale

and $\frac{5}{6}$ of $\frac{4}{5}(\frac{3}{4}x-6)-2=18$, No. after third sale.

$$\frac{x-8}{2}-2=18$$
$$x-8-4=36$$
$$\underline{x=48.}\ \text{Ans.}$$

Mensuration.

The area of a square field is equal to the area of a rectangle whose sides are 21 ft. 11 in. and 197 ft. 3 in.; find the side of the square.

21 ft. 11 in. × 197 ft. 3 in.
$=263\times2367$
$=622521$ sq. inches.
$\sqrt{622521}$
$=789$ inches
$=\underline{65 \text{ feet } 9 \text{ inches.}}$ Ans.

Arithmetic.

FEMALES.

1. Simplify $\dfrac{4\cdot4+\frac{2}{5}}{7\cdot375-\frac{1}{8}+\frac{3}{4}}$ and express your answer *decimally*.

$$\frac{4\cdot4+\frac{2}{5}}{7\cdot375-\frac{1}{8}+\frac{3}{4}}$$
$$=\frac{4\cdot4+\cdot6}{7\cdot375-\cdot125+\cdot75}$$
$$=\frac{5}{8}$$
$$=\underline{\cdot625.}\ \text{Ans.}$$

2. Reduce $\frac{3}{5}$ of a guinea + $\frac{1}{2}$ of $\frac{3}{4}$ of £1 + $\frac{4}{5}$ of $\frac{3}{4}$ of a crown + $\frac{1}{2}$ of $\frac{1}{5}$ of 1s. to decimals of £1 and of £100.

s.
$\frac{3}{5}$ gui. $=\frac{3}{5}\times\frac{21}{1}=\frac{14}{5}=\frac{112}{40}$
$\frac{1}{2}$ of $\frac{3}{4}$ of £1 $=\frac{1}{2}\times\frac{3}{4}\times\frac{20}{1}=\frac{15}{2}=\frac{180}{24}$
$\frac{4}{5}$ of $\frac{3}{4}$ of a cr. $=\frac{4}{5}\times\frac{3}{4}\times\frac{5}{1}=\frac{15}{5}=\frac{60}{24}$
$\frac{1}{2}$ of $\frac{1}{5}$ of 1s. $=\frac{1}{10}=\frac{2}{24}$
$=\frac{357}{24}=\frac{119}{8}$ } $=\frac{357}{24}$s.

$\frac{357}{24}$s. to the dec. of £1 $=\frac{357}{24}\times\frac{1}{20}=\frac{357}{480}=\underline{\cdot74375}$. Ans.

To dec. of £100 $=\cdot74375\div100=\underline{\cdot0074375}$. Ans.

3. A man undertakes a journey. He walks $\frac{1}{3}$ of the distance the first day; ·25 of what remained on the second day; ·3 of what still remained on the third day, thus leaving 12 miles for the fourth day. What was the length of the journey?

First day walked $\frac{1}{3}$ left $\frac{2}{3}$
Second day walked ·25 of $\frac{2}{3}=\frac{1}{6}$ left $=\frac{2}{3}-\frac{1}{6}=\frac{3}{6}$
Third day walked ·3 of $\frac{3}{6}=\frac{3}{10}$ of $\frac{3}{6}=\frac{9}{20}$ left $=\frac{3}{6}\times\frac{7}{10}=\frac{7}{20}$
$\therefore\ \frac{7}{20}=12$ miles
$\frac{1}{20}=12\times4=\underline{48 \text{ miles.}}$ Ans.

4. What is a *decimal* fraction? State and *prove* the rule for converting a decimal into a vulgar fraction, and apply your rule to the conversion of ·207 into a vulgar fraction.

A decimal fraction is one whose denominator is 10 or a power of 10, the denominator being known by fixing a point as many figures to the right of the numerator as there are cyphers in the denominator.

Write as many o's prefixed by 1 as there are decimal places in the number.

$$\cdot207=\frac{207}{1000}.$$

Since a figure one step to the right from the units' place is $\frac{1}{10}$th the value of the same figure in the units, and in the second place $\frac{1}{100}$th, and in the third place $\frac{1}{1000}$th, it follows that ·207 = $\frac{2}{10}$, $\frac{0}{100}$, and $\frac{7}{1000}$. The common denominator of these fractions is 1000, and when reduced the numbers are 200, 0, 7, which, added, yield $\frac{207}{1000}$.

Grammar.

MALES AND FEMALES.

1. An *inadvertent* step *may crush* the snail,
That crawls at *evening* in the public path;
But *he that* has *humanity*, *forewarned*,
Will tread aside and *let* the reptile *live*.

Analyse the above passage, parsing the words in italics.

ANALYSIS.

Sentence.	Kind of Sent.	Connective.	Subject.	Predicate.	Object.	Extension.
(*a*) An inadvertent step may crush the snail	P.S.		An inadvertent step	may crush	the snail	
(*b*) that crawls at evening in the public path	Adj. to *snail* in (*a*)	*In rel*	that	crawls		at evening (*time*) in the public path (*place*)
(*c*) but he, forewarned, will tread aside	P.S. adverse to (*a*)	but	he, forewarned	will tread		aside (*place*)
(*d*) and let the reptile live	Princ. co-ord. with (*c*)	and	[he]	will let	the reptile (to) live	
(*e*) that has humanity	Adj. to *he* in (*c*)	*In rel.*	that	has	humanity	

PARSING.

Inadvertent—Adj. of quality, qual. 'step.'
may—aux. verb to 'crush,' indicating pot. mood.
crush—verb, reg. trans., act., inf., gov. by 'may.'
may crush—verb, reg. trans., act., pot., pres., 3rd, sing., agreeing with 'step.'
that—rel. pro., 3rd, sing., com., nom. to 'crawls.'
crawls—verb, reg. intrans., act., ind., pres., 3rd, sing. agreeing with 'that.'
evening—noun, abs., neut., sing., 3rd, obj., gov. by 'at.'
he—pro., pers., masc., sing., 3rd, nom. to 'will tread.'
that—pro., rel., masc., sing., 3rd, nom. to 'has.'
humanity—abs. noun, neut., sing., 3rd, obj., gov. by 'has.'
forewarned—part. adj. of quality, qual. 'he.
will—aux. verb to 'tread,' indg. future tense
tread—verb, irreg. intrans., act., inf., pres., gov. by 'will.'
will tread—verb, irreg. intrans., act., ind., fut., 3rd, sing., agreeing with 'he.'
aside—adv. of manner, qualg. 'will tread.'
let—verb, irreg. trans., act., inf., gov. by 'will.'
live—verb, reg. intrans, verb, act., inf., gov. by 'will let.'

2. Explain how the word 'aside' is formed, and give instances of adverbs of similar formation.

Aside is formed from the prefix *a*, which means *in* or *on*, and the noun *side*. *A* having the force of a preposition, the word may be said to be formed of a preposition and a noun.
Other adverbs :—abed, afoot, ashore.

3. Point out a Latin prefix and a Latin suffix in the above.

Prefix: *in* in *inadvertent*.
Affix: *ent* in the same word.

4. Correct, if needful, the following sentences :—

(*a*) It is I that he fears.
(*b*) He is a boy of nine years old.
(*c*) Who can this letter be from?
(*d*) I feel coldly this morning.

(*a*) It is I whom he fears.
(*b*) He is a boy nine years old.
(*c*) Whom can this letter be from?
(*d*) I feel cold this morning.

Geography.

1. Draw a full map of Egypt, showing the position of the Soudan and of the places connected with the present war.
N.B.—Insert the lines of latitude and longitude.

2. Gives notes of a Lesson on 'China, its physical character, chief towns and rivers, and the character of the people.'

Physical character.—1600 miles long, 1300 miles broad. Consists of a series of large river basins opening out to a long flat coast in the east, but the watersheds are mountainous in the west. Chief ranges Pe-ling, Nan-ling, Sin-ling, Yun-ling, in China proper; Thian-Shan, Tangua Oola separating it from Siberia, and the Himalaya from India; Kling Khan in Mongolia; In-shan in the centre. Between the Himalayas and the Thian-Shan lies the sandy, rainless desert of Gobi, extending 1000 miles from east to west.

Rivers.—Amoor in the N., partially in Siberia: Hoang-ho and Yang-tse-kiang, rising near each other and flowing eastward, the Canton river, and the Peiho river. Volume of water great, carries down great quantities of mud, (hence *Yellow* river and sea.) Describe 'bore' caused by water meeting tide.

Chief towns.—China very populous; hence towns large with narrow streets, crowded houses and streets.

Pekin, on Peiho, capital, walled, fortified, end of great canal, 770 miles long; *Nankin*, formerly capital, nearly a million people, ruins, pagodas, temples; *Canton*, or Se-kiang, 800,000 people, first port, great river population; *Amoy*, *Foochew*, *Ning-po*, *Shang-hai*, are ports, *Tien-Tsin* on canal.

People.—Very industrious, possessing much manufacturing skill and ingenuity, performing with ease delicate work of different kinds; fond of their country, to which they return if possible, after having made money elsewhere. Averse to mixing with strangers, who were excluded from the country till recently. Disciples of Confucius, a deist, or worshippers of Fo, probably the same as Hindoo Buddha.

3. What are Monsoons? Where are they felt? And what are their effects?

Monsoons are trade winds, modified by the climates of the countries over which they pass. They are felt along the east coast of Africa, but more especially in India. They blow from N.E. from November to March, and from S.W. from April to October. When once established, the S.W. Monsoon coming across the Indian Ocean is charged with moisture, which falls in great showers of rain on the W. Ghauts. The west of India has thus periodical rains as one result of the monsoons. The N.E. Monsoon in a similar manner, carries rain to the coast of Africa. At the time of the change of monsoons, great quantities of rain, attended by storms of thunder, are precipitated.
Monsoons, not so decided as those of the Indian Ocean, are common between Australia and China, and on the Coasts of Mexico and Brazil.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination papers.

Arithmetic.

MALES.

1. If I buy railway stock, paying a dividend of $6\frac{1}{2}$ per cent., at $129\frac{1}{4}$, what rate per cent. do I get for my money, the usual brokerage being charged?

I receive £$6\frac{1}{2}$ for £$(129\frac{1}{4}+\frac{1}{4})$.
∴ Rate of interest = As 130 : 100 :: $6\frac{1}{2}$: $\underline{5}$. Ans.

2. What principal will amount to £594·88 at compound interest in 2 years at 4 per cent. per annum?

4 p. c. = $\frac{1}{25}$	100
	4
4 p. c. = $\frac{1}{25}$	104 End of 1st year.
	4·16
	108·16 End of 2nd year.

£ £ £ £
∴ 108·16 : 594·88 :: 100 : $\underline{550}$. Ans.

3. State the rule for pointing in square root. Find to three places of decimals the square roots of 168·1, ·2, and 01.

Place a point over the units figure, and then over every second figure to the left, and also to the right when there are decimals.

If a period is not complete in the decimal fraction, add a 0 to complete it.

168·100000(12·965. Ans.
1
22) 68
44
249) 2410
2241
2586) 16900
15516
25925) 138400
129625
8775

·200000(·447. Ans.
16
84) 400
336
887) 6400
6209
191

·011111(·105. Ans.
1
205) 1111
1025
86

4. If a grocer by selling tea at 2s. 6d. per lb. gains 12 per cent., what did it cost him per cwt.?

Selling price = 2s. 6d. × 112 = £14
" " = cost price + gain
= 100 + 12
= 112 per cent.

£ £ £ £ s.
∴ 112 : 100 :: 14 : 12 10

History.

MALES AND FEMALES.

1. Trace the descent of Queen Victoria from James I.

James I.
|
Elizabeth mar. Fredk. of Bohemia.
|
Sophia, mar. Elector of Hanover.
|
George I.
|
George II.
|
George III.
|
Edward, Duke of Kent.
|
Victoria.

2. Who was Queen Anne? Mention persons illustrious in war and in literature during her reign.

Queen Anne was the younger daughter of James II. She succeeded to the throne of England on the death of her brother-in-law, William III., in 1702.

War.—Duke of Marlborough, Prince Eugene, Sir George Rooke.

Literature.—John Locke, Sir Isaac Newton, Alexander Pope, Joseph Addison, Sir Richard Steele, Daniel De Foe, Dean Swift.

3. How do you account for the success of the American colonists in the War of Independence?

The colonists were fighting for the independence which they had enjoyed since leaving this country. They were roused as a whole nation to the conflict. They were cheered by success at the first. They were led by men of superior ability, in whom they placed every confidence, while, in some instances, the British forces were led by men much less fit for their work. They had everything to gain, and much to lose in the conflict, and inspired by help from France, and the lukewarmness of many of the English, there was little wonder that they were successful.

Teaching.

Write the notes of a lesson to a Sixth Standard on 'Latin Prefixes.'

Formation of Words.—Recapitulate results of previous lessons in Standard V. on 'Word Building.' Show how compound words were made of two simple words, and that gradually one part of the word changed in form, and sometimes in meaning, *e.g.*, be-cause for by-cause, a-foot for on-foot.

Prefixes.—When these words have lost their original form, or when they are put before other words, we call them *prefixes*. The meaning of many is arrived at by comparing many words. Numbers of prefixes, and especially in Latin, are only the Latin prepositions put to roots of verbs or nouns.

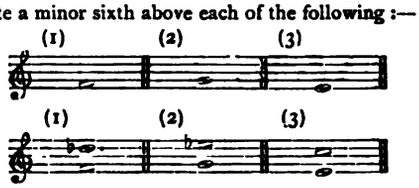
Use of Prefixes.—For forming words from roots. Words so formed called *Derivatives*. Give examples, and show how some of the prefixes take different forms to adapt themselves to the roots to which they are prefixed, *e.g.*, *con* becomes co, cog, col, com; *e* has the form of ex, ef. Compare the same prefix in different words, and show that the meaning varies with the use of words. Recapitulate, and ask for division of words into roots and prefixes to show that the lesson has been understood.

Music.

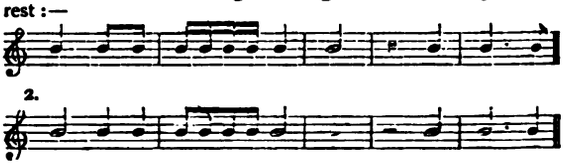
A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write a minor sixth above each of the following:—



2. Re-write the following, doubling the value of every note and rest:—



3. State briefly the meanings of the following terms:—(1) *Da Capo*; (2) *Dal Segno*; (3) *Vivace*.

3. (1) Repeat from the beginning; (2) repeat from the sign; (3) lively, sprightly.

TONIC SOL-FA NOTATION.

1. Write minor sixths above the following:—(1) *me*; (2) *lah*; (3) *te*.

1. (1) *doh*^{1}; (2) *fah*^{1}; (3) *soh*^{1}.

2. What are the five kinds of measure commonly used?

2. Two-pulse; three-pulse; four-pulse; six-pulse; nine-pulse.

3. Explain the following terms:—(1) *Da Capo*; (2) *Dal Segno*; (3) *Vivace*.

3. (1) Repeat from the beginning; (2) repeat from the sign; (3) lively, sprightly.

FOURTH YEAR.

Pupil Teachers at end of Fourth Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including No. 3, if you can do so.

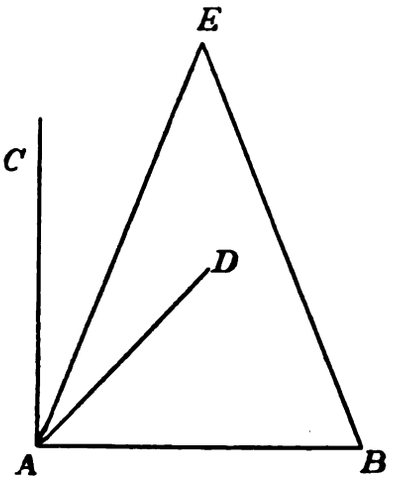
1. If a straight line be divided into two equal parts, and also into two unequal parts; the rectangle contained by the unequal parts, together with the square on the line between the points of section, is equal to the square on half the line.

Euclid, Bk. II., Prop. 5.

2. In obtuse-angled triangles, if a perpendicular be drawn from either of the acute angles to the opposite side produced, the square on the side subtending the obtuse angle, is greater than the squares on the sides containing the obtuse angle, by twice the rectangle contained by the side upon which, when produced, the perpendicular falls, and the straight line intercepted without the triangle between the perpendicular and the obtuse angle.

Euclid, Bk. II., Prop. 12.

3. Construct a triangle having each of the angles at the base one and a half times the vertical angle.



At point A in straight line AB erect perpendicular AC. Bisect ∠ BAC by straight line DA (I. 9). Bisect ∠ DAC by straight line AE (I. 9). At point B make ∠ ABE = ∠ BAD. Produce BE and AE to meet in E. BAE is the triangle required.

∵ BAC is a right ∠, and DA bisects it, ∠ BAD is half a right ∠, and ∵ ∠ DAC, which is half a right ∠, is bisected by EA, ∠ DAE is ¼th of right ∠. ∴ ∠ BAE is ¾ths of a right ∠; and (Const.) ∠ ABE is also ¾ths of a right ∠.

And since three ∠'s of a △ = two right ∠'s, ∠ AEB is half a right ∠.

∴ Each of the ∠'s at the base is one and a half times the ∠ at the vertex. Q. E. F.

Algebra.

Answer two Questions, including the first Question, if you can.

1. *Prove* the rule for multiplying and for dividing a fraction by an integer.

Multiply together $\frac{1-a^2}{b+b^2}$, $\frac{1-b^2}{a+a^2}$, and $b+\frac{ab}{1-a}$

Proof for multiplication:

When the numr. is multiplied. Let $\frac{x}{y}$ denote any frac. and z any integer: then $\frac{x}{y}\times z=\frac{xz}{y}$. For in each of the fracs. $\frac{x}{y}$ and $\frac{xz}{y}$, the unit is divided into y parts and z times as many parts are taken in $\frac{xz}{y}$ as in $\frac{x}{y}$: hence $\frac{xz}{y}$ is z times $\frac{x}{y}$.

When the denr. is divided. Let $\frac{x}{yz}$ be any frac. and z any integer. Then $\frac{x}{yz}\times z=\frac{x}{y}$. For in each frac. $\frac{x}{yz}$ and $\frac{x}{y}$, the numr. is the same, but each part in $\frac{x}{y}$ is z times as large as in $\frac{x}{yz}$ because in $\frac{x}{yz}$ the unit is divided into z times as many parts as in $\frac{x}{y}$, hence $\frac{x}{y}$ is z times as great as $\frac{x}{yz}$.

$$\frac{1-a^2}{b+b^2}\times\frac{1-b^2}{a+a^2}\times b+\frac{ab}{1-a}$$
$$=\frac{(1-a)(1+a)}{b(1+b)}\times\frac{(1-b)(1+b)}{a(1+a)}\times\frac{b}{1-a}$$
$$=\underline{\frac{1-b}{a}}\cdot \text{ Ans.}$$

2. Find the relation between a, b, c, in order that ax^2+bx+c may be a perfect sq.

Extract the square root of—

$$x^4-4x^3+10x^2-12x+9.$$

Extract the sq. root of ax^2+bx+c, and equate the remainder to zero; thus,

$$\begin{array}{l|l} ax^2+bx+c & \left(x\sqrt{a}+\frac{b}{2\sqrt{a}}\right. \\ \underline{ax^2} & \\ 2x\sqrt{a}+\frac{b}{2\sqrt{a}}\Big)bx+c & \\ \underline{bx+\frac{b^2}{4a}} & \\ c-\frac{b^2}{4a} & \end{array}$$

The relation is therefore, that

$$c-\frac{b^2}{4a}=0, \text{ or that } \underline{b^2=4ac.}$$

$$\begin{array}{l|l} x^4-4x^3+10x^2-12x+9 & (x^2-2x+3 \\ \underline{x^4} & \\ 2x^2-2x)\ -4x^3+10x^2 & \\ \underline{-4x^3+4x^2} & \\ 2x^2-2x+3)\ 6x^2-12x+9 & \\ \underline{6x^2-12x+9} & \end{array}$$

3. Solve the equations—

(1) $111x-\frac{y}{111}=2=\frac{y}{37}-37x.$

(2) $x-a+\frac{5}{x-a}=6.$

(1) $111x-\frac{y}{111}=2$ (I.)

$-37x+\frac{y}{37}=2$ II.

Mult. II. by 3

$111x-\frac{y}{111}=2$

$\underline{-111x+\frac{3y}{111}=6}$

$\frac{8y}{111}=8$

$8y=888$

$\underline{y=111.}$ Ans.

Substitute value of y in I.

$111x-\frac{111}{111}=2$

$111x-1=2$

$111x=3$

$\underline{x=\frac{1}{37}.}$ Ans.

(2) $x-a+\frac{5}{x-a}=6$

$(x-a)^2+5=6(x-a)$

$(x-a)^2-6(x-a)=-5$

$(x-a)^2-6(x-a)+3^2=9-5$

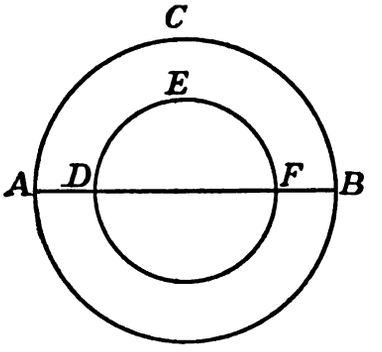
$x-a-3=\pm 2$

$\underline{x=5+a.}$ Ans.

Or, $\underline{x=a+1.}$ Ans.

Mensuration.

Show that the area of a circular ring may be (approximately found by multiplying together the sum and difference of the inner and outer diameters and $\frac{11}{14}$.



Let ACB and DEF be two circles, DEF being the less, having diameters of 6 and 4 respectively.

Then the area of ring = area of large − area of less circle.

Area of large circle $= 6^2 \times .7854 = 28.2744$
,, small ,, $= 4^2 \times .7854 = 12.5664$
,, ring $= 15.7080$

$(6+4) \times (6-4) \times \frac{11}{14} = \frac{220}{14} = 15\frac{10}{7} = 15.7142$. Ans.

Arithmetic.

FEMALES.

1. Divide £22 9s. 2d. among 3 persons so that one has twice as much as the second, and three times as much as the third.

Their shares will be in the ratio of 6, 3, 2,
Total shares, 11.

		£ s. d.	£ s. d.	
The first will get	$\frac{6}{11}$ of	22 9 2	= 12 5 0	Ans.
,, second ,,	$\frac{3}{11}$,,		= 6 2 6	
,, third ,,	$\frac{2}{11}$,,		= 4 1 8	

2. Find the cost of carpeting a room 18 ft. 9 in. long and 17 ft. 6 in. broad, with carpet 2 ft. wide at 4s. 9d. a yard.

$$\text{No. of yds. reqd.} = \frac{18\frac{3}{4} \times 17\frac{1}{2}}{2 \times 3}$$

$$\text{and the cost} = \frac{18\frac{3}{4} \times 17\frac{1}{2} \times 4\frac{3}{4}}{2 \times 3}$$

$$= \frac{75}{4} \times \frac{35}{2} \times \frac{19}{4} \times \frac{1}{2} \times \frac{1}{3}$$

$$= \frac{49875}{96}$$

$= £12\ 19s.\ 9\frac{3}{16}d.$ Ans.

3. A merchant buys a 50 gallon cask of wine for £62 10s. and sells it at 26s. per gallon; what is his total gain and gain per cent.?

	£	s.
Selling price = 26s. × 50 =	65	0
Cost price =	62	10
Total gain =	2	10. Ans.

£ s. £ s. £
∴ 62 10 : 100 :: 2 10 : 4 Gain per cent.

4. A person wishes to make an income of £100 per annum by investing £2666 13s. 4d. in the 3 per cent. Consols; find what price they must be quoted at when he buys in.

£ £
100 is produced by $2666\frac{2}{3}$
1 ,, ,, $\frac{2666\frac{2}{3}}{100}$
3 ,, ,, $\frac{2666\frac{2}{3} \times 3}{100} = £80$; the price. Ans.

Grammar.

MALES AND FEMALES.

1.

Mighty *winds*,
That sweep the skirt of some *far-spreading* wood
Of ancient *growth*, *make music not unlike*
The *dash* of ocean on its winding shore,
And *lull* the spirit while they fill the mind.

Analyse the above, parsing the words in italics.

ANALYSIS.

Sentence.	Kind of Sentence.	Connective.	Subject.	Predicate.	Object.	Extension.
(*a*) Mighty winds make music not unlike the dash of ocean on his winding shore	Princ. sent.		Mighty winds	make	music not unlike the dash of ocean on his winding shore	
(*b*) that sweep the skirt of some far-spreading wood of ancient growth	Adj. sent. to *winds* in *a*	*In rel.* pro.	that	sweep	the skirt of some far-spreading wood of ancient growth	
(*c*) and lull the spirit	Princ. sent. co-ord. with *a*	and	[they]	lull	the spirit	
(*d*) while they fill the mind	Adv. sent. (time) to *a* and *c*	while	they	fill	the mind	

PARSING.

Winds—noun, com., neut., plur., 3rd, nom. to 'make.'
that—pro., rel., neut., plur., 3rd, nom. to 'sweep.'
far-spreading—compound part. adj., of quality, qual. 'wood.'
growth—noun, abs., neut., sing., 3rd, obj., gov. by 'of.'
make—verb, irreg. trans., act., ind., pres., 3rd, plur., agreeing with 'winds.'
music—noun, com., sing., neut., 3rd, obj., gov. by 'make.'
not—adv. of negation. qual. 'unlike,'
unlike—adj. of quality, qual. 'music.'
dash—noun, abs., neut., 3rd, sing., obj, gov. by adj. 'unlike.'
lull—verb, reg. trans., act., ind., pres., 3rd, plur., agreeing with 'they' und.

2. What sort of word is 'far-spreading'? Give examples of *other* combinations in compound adjectives.

Far-spreading is a compound adjective, made up of a participle and an adverb.

Other combinations: Noun and Adjective—snow-white, wilful, brand-new, stone-blind.

Verb and Adverb:—well-bred, under-done, over-done, high-born.

3. What is the force of 'un' in the word 'unlike,' and what other meaning has it when prefixed to a verb? Give examples.

Un in *unlike* means not. It also means *back*, as untie, unlock, undo, unroll, unfold, unbar.

4. Mention some of the principal events that have contributed to bring our language into its present form.

English is a Teutonic language, brought over by the Saxons from Germany at the invasion in the 4th century. It is, however, very largely mixed up with words which have a different origin, these words having been introduced in the following ways:—Some words were adopted from the ancient inhabitants of this country. These are Keltic. A few Latin words from the Romans are found in the language; the bringing of Christianity by missionaries introduced many more connected with the Church. When the Normans invaded England they brought still more Latin words, slightly changed in form by coming through the French. The revival of learning in the 15th century added more still. The great amount of commerce England has, her connection with every nation in the world, and the importance of the country generally, have added words from nearly every known language. In this way we have Spanish, Italian, Portuguese, Turkish, Hindu, Persian, Malay, American, and other words in the language, making English the most composite of known languages.

Geography.

(*Answer two Questions including Q.* 1.)

1. Draw a full map of Australia, including Tasmania. Insert lines of latitude and longitude.

2. Give notes of a lesson on 'Day and Night.' Illustrate by diagrams.

Introduction.—Draw attention to parts of day, eliciting names, morning, forenoon, noon, afternoon, evening, midnight, dawn, and twilight. Also that light is derived from sun.

Cause of Day and Night.—Show that phenomena might be caused in *two* ways—(*a*) by earth turning round on its axis; or, (2) by sun going round the earth. Latter formerly believed. Hence common expressions, *sunrise* and *sunset*, *sun going from east to west*, etc. Former the real cause. Illustrate by candle and globe, or by sun shining through window on globe. From same illustration show the way in which dawn, sunrise, sunset, and twilight are caused.

Day and night at different times in different places.—Morning at all places on same meridian at same time. (Show how). There being 360° round the earth, and a rotation of the earth taking place every 24 hours, time is one hour later for every 15°.

Show globe or map, and give exercises and examples.

Benefits of day and night.—Time of rest, provision for radiation, cooling of earth, formation of dew necessary to the earth's vegetation.

3. 'All the long and gentle slopes descend towards the Atlantic Ocean; all the short and rapid slopes towards the Pacific, and its continuation, the Indian.'

Show from each continent, as fully as you can, that this statement is true.

In America the Rocky Mountains and their continuation, the Andes, are within a comparatively short distance from the Pacific; and all the great rivers, Mississippi, St. Lawrence, Amazon, Orinoco, La Plata, etc., flow to the Atlantic. No large rivers flow into the Pacific.

In Europe the rivers are all drained into the Atlantic Ocean and its seas, and the axis of the mountain chains is much nearer the southern part of the Continent than the northern.

In Africa the high lands are near the coast, but the mountains of southern Soudan are much nearer the Indian than the Atlantic Ocean, thus leaving the longest slope towards the Atlantic.

In Asia the mountain chains run from N.E. to S.W., the ranges beginning near the Pacific and keeping near that ocean and the Indian throughout their entire length. The southern slope of the Himalayas is abrupt and rugged, but long and gentle to the north till it reaches the Arctic Ocean.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination papers.

Arithmetic.

MALES.

1. If a cubic foot of water weighs 62·5 lbs., and half a pint weighs 10 oz., find the number of cubic inches in a gallon.

One gallon = 16 half-pints;
Then weight of one gall. = 16 × 10 = 160 ozs.
62·5 lbs. = 1000 ozs.
oz. oz. cub. in. cub. in.
∴ 1000 : 160 :: 1728 : 276·48. Ans.

2. A man wishes to divide £11,400 amongst his two sons and daughter in such a way that the eldest son may get half as much again as the second, and the second son half as much again as the daughter. Find their shares.

Their shares will be in the proportion of 1, 1½, and 2¼, or 4, 6, and 9. Total shares 19.

The eldest son will get $\frac{9}{19}$ of £11400 = £5400. Ans.
The second son ,, $\frac{6}{19}$,, = £3600. Ans.
The daughter ,, $\frac{4}{19}$,, = £2400. Ans.

3. A man invests money in the 3 per cents. at 97½, and after a year sells out at 101½, and the interest and profit on the sale amount to £145. How much money did he invest, brokerage being charged on each transaction?

The buying price of Stock was 97½ + ½ = 97¾.
,, selling ,, ,, ,, 101½ − ½ = 101¼.
The gain on each £97¾ spent was 101¼ − 97¾ = 4½.
The interest + gain = 4½ + 3 = 7½.
No. of £97¾'s spent was $\frac{145}{7\frac{1}{2}} = 20$.
Amount invested = 97¾ × 20 = £1950. Ans.

4. A, who walks 4½ miles an hour, and B who walks 4¾, start together to walk round a ring 6 miles in circumference; find when they will be together next, and at what distance from the starting-point.

B gains on A (4¾ − 4½) = ¼ m. per hour.
As the course is 6 m. round, he will overtake him in 6 ÷ ¼ hr. = 16 hours.
In 16 hrs. A travels 4½ × 16 = 68 miles.
,, ,, B ,, 4¾ × 16 = 74 ,,
68 miles is 11 times the course + 2 m.
74 ,, 12 ,, ,, + 2 m.
They would therefore be 2 m. from the starting-point.
16 hours; 2 miles. Ans.

History.

MALES AND FEMALES.

1. 'No living Englishman can say with certainty that the blood of Celt and Gaul, Welshman and Irishman, Frisian and Flamand, French, Huguenot, and German Palatine does not mingle in his veins.' Explain the statement.

The ancient inhabitants of this country were Celts, and in 1066 there was an invasion from Gaul, the Normans remaining in the country. Welshmen and Irishmen have settled in this country at all times since the conquest of these countries in the 12th century. Frisians were among the invaders and settlers in the 4th and later centuries. Flamands came in the time of the Conqueror, and made a descent on Suffolk in the time of Henry II., and were encouraged to settle by Edward III. The French Huguenots, to the number of 50,000, settled in England after the revocation of the edict of Nantes, while of Germans the main body of English may be said to be composed. Having all settled and intermarried in the course of many centuries a general mixture of the races has taken place.

2. What is meant by a convention parliament? Give particulars of any such parliaments.

A convention parliament is one which is summoned for a specific purpose, without having been called by the king.

After the dissolution of the Long Parliament by its own act in 1660 a new parliament met for the purpose of recalling Charles II.

In 1688, after the flight of James II., a convention parliament met for the purpose of offering the Crown to William Prince of Orange.

A third convention parliament met in 1788 during the insanity of George III., for the purpose of deciding upon a Regency while the king was unfit to perform the duties of his office.

3. What causes produced the Irish rebellion of 1798?

During the latter part of the eighteenth century, attempts were made to do away with the legislative independence of Ireland, and in the sixth year of George I. the Irish House of Lords was deprived of its appellate jurisdiction, and the Act also declared that the English Parliament had the right to make laws to bind the Irish people. The Irish Parliament was filled with persons in the pay of England. A rebellious spirit now arose in the country. The *Freeman's Journal* was established. Attacks were made on the English Government. Secret societies were formed in large numbers, and sedition was rife. Grattan wished and worked for legislative independence, and when the American war broke out (1774) his opportunity arrived. The volunteers formed a Convention to assist him, and the result was the repeal of the Act of the sixth year of George I. Then differences arose between the leaders. Some, the more embittered against England, were not satisfied, and these, roused by the success of the French revolution, determined to fight for freedom. Their chief leaders were Tone, Fitzgerald, and O'Connor. The former obtained the assistance of a French fleet, which was, however, destroyed by bad weather. The Government became alarmed, sent soldiers over to Ireland in large numbers, who were lodged in different parts of the country, and committed great excesses. The people then rose in rebellion.

Teaching.

Write out notes of a lesson on 'WATER AND ITS FORMS.'

Apparatus needed.—If possible have water, a test tube, spirit lamp, and piece of ice.

I. *Water as a liquid.*—Draw attention to water as commonly seen as a *liquid*, and show that (*a*) its particles move freely about; (*b*) that it is nearly incompressible; (*c*) that it presses equally on all sides; (*d*) and that it finds its level.

Call attention to fact of its wide diffusion, ocean, seas, rivers, lakes.

II. *Water as a gas.*—Pour a little water on a slate, place over spirit lamp. Observations made—(*a*) heat turns water into *steam*; (*b*) steam invisible; (*c*) when partially *condensed* called *vapour*; (*d*) heat expands water (seen in test tube).

Effect of sun on surface of earth similar. Roads dry up; vast quantities of vapour raised from sea form clouds. Condensation by coming in contact with cold. Examples: breath on slate, vapour in a room, clouds, fog, mist, dew.

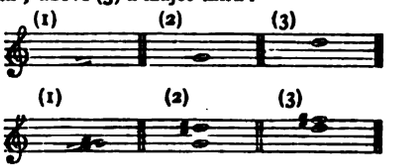
III. *Water as a solid.*—Show ice, expose to heat turn to water. From experiment derive—(*a*) water exists as a solid as ice; other forms, snow and hail; (*b*) that it is converted into liquid by heat; (*c*) that ice when melted occupies less space when liquid than when solid.

Music.

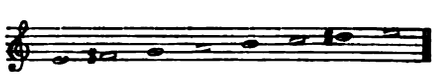
A quarter of an hour allowed for this paper.

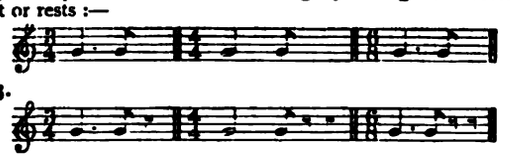
(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write above (1) an augmented second; above (2) an augmented fifth; above (3) a major third:—



2. Write the ascending scale of E minor, using the minor sixth and the sharp seventh, placing the necessary sharps before the notes:—



3. Complete each of the following by adding the necessary rest or rests:—

TONIC SOL-FA NOTATION.

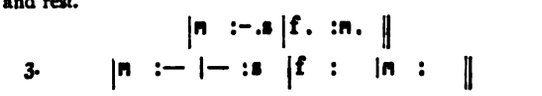
1. Write above (1) *fah* an augmented second; above (2) *sah* an augmented fifth; above (3) *ray* a major third.

1. (1) *se*; (2) *re*^{1}; (3) *fe*.

2. In the minor mode (*a*) what is the essential sixth; and (*b*) what is the essential seventh;

2. (*a*) *fah*; (*b*) *se*.

3. Re-write the following, doubling the value of every note and rest.



Friedrich Fröbel.

BY HIS PUPIL, HEINRICH HOFFMAN.

X.—(*continued.*)

BUT great as were their difficulties, neither Fröbel nor his friends despaired of ultimate success. In 1828 Fröbel wrote to Barop:—

'Our outer life is still in its undeveloped state, and still shrouded in dark, stormy night, the black clouds of which may at any time send forth their disastrous flash of lightning. However, so far, God, with His mighty arm, has ever held His protecting shield over us, and like chickens in a storm beneath the sheltering wings of their mother, so we have been permitted, amidst the terrors of the tempest, to rest in the lap of the faithfully tender mother. . . . Never mind what they say about us in Berlin; continue to act faithfully to your conviction. As to myself, everything becomes clearer. That which formerly was founded in my belief, in my conviction, and but partially in my own intuition, I now see in all creation, in the development of things, in nature, in Divine dispensation, and in the course of culture in mankind; God in creation, in nature, and in the order of the universe, in the culture of mankind. God the original idea of man's education—this is the foundation stone of my inner and outer life! On this foundation you may maintain the rights of nature with more than Lutheran rock-like firmness, and thus act as a champion for our educational scheme.'

What a very checkered, motley life was Fröbel's! What ups and downs; what sudden changes between brilliant flashes of light and utter darkness! And what is the meaning of the grand rising of that luminous star yonder? Will it at last lead the storm-beaten mariners to a safe port? Yes, so it seems. The Duke of Meiningen had his attention drawn to the wonderful doings at Keilhau; had desired Fröbel to initiate him in his educational schemes; had held frequent interviews with him, and proposed to found a national school on an extensive scale, where Fröbel could carry out his plans unfettered and quite in his own way. The preliminaries were agreed upon. Fröbel was to have the large estate of Helba, with all the extensive grounds belonging thereto, and an annual subsidiary grant of one thousand florins.

What a festival of joy at Keilhau when thus the long-hoped-for harbour came in sight! Fröbel was all excitement, all animation, all eagerness, to draw up the plans; and never was any scheme more exactly and carefully elaborated, even to the minutest detail. With restless energy he worked at it for several months, and we can imagine his delight as he thought of the bright vision before him!

Mere teaching could not satisfy Fröbel. Practical exercises in wood, in paper, in pasteboard, in garden and field, were to supplement and elucidate the oral lessons; practical work was to stimulate theoretical inquiry; on it theory was to rely for confirmation. Man was to be educated not merely as a receptive being but as an active and producing one. Work, instruction, and play were to form one undivided whole. Rapidly his plans expanded to stupendous dimensions. Not only would he have an educational institution for boys, but also a home for motherless children and orphans from three to seven years of age, a college of German art and industry, whilst Keilhau was to be raised to a high school where young men could be prepared for the University.

'All in vain,' seems to be the natural sigh of our disappointed minds when we learn how the jealousy of narrow-minded ministers had been at the mean work of poisoning the Duke's mind against Fröbel. Although the agreement was signed, and the institution publicly advertised, Fröbel withdrew at once when he detected a lurking distrust.

No, 'All in vain' would be a short-sighted verdict; to call the whole affair a will-o'-the-wisp would not be quite correct, inasmuch as with the assiduous and careful working out of the plans, a great and decisive step had been taken towards the crowning of his life's labours.

To us, who can survey at one glance, cause, facts, and results of a bygone period, it matters but little that such ardent hopes and expectations were again doomed to disappointment. Keilhau was now too narrow for him: he had tried his wings, and found them strong enough for a higher flight. Besides, with so small a number of pupils, it was impossible to keep up an establishment of three or four families. So Fröbel proceeded to Frankfort to consult his dear friends. Frau von Holzhausen proved once more his faithful genius. She introduced him to Herr Schnyder von Wartensee, a musical composer of great renown, a pupil of Beethoven, and, at one time, the music master at Pesta-

lozzi's establishment at Yverdun. This gentleman was quite fascinated with Fröbel's educational views, and being possessed of considerable means, he liberally offered him his chateau, 'Wartensee,' on lake Sempach, in Switzerland, for the realization of his plans. On the 12th of August, 1831, an official document was delivered to Herr Schnyder, which deserves to be recorded:—

'The Educational Council of the Canton of Luzern to
'Herr Xaver Schnyder von Wartensee.

'Most Esteemed Sir,—We take great pleasure in communicating to you and to Herr Friedrich Fröbel the decree of the Committee, by which your plan to establish a private school at Wartensee, has been approved of, and legal permission thereof granted.

'We congratulate our canton on the acquisition of a school which, under such intelligent leaders, cannot fail to exercise the most beneficial influence on all our scholastic institutions, and have the honour to offer you our special protection, and to assure you of our hearty co-operation, on which you may always rely in anything that can further the prosperity of so philanthropic, and so noble an undertaking.

'Accept, sir,' etc.

Such a welcome must have been encouraging indeed! With a noble generosity not often met with, Schnyder placed at Fröbel's service a fine mansion, furnished, not only completely, but in a style almost princely, with even a rich store of plate. Really, the key to his Eldorado seemed to be in his hands at last! His nephew, Ferdinand Fröbel, son of his brother Christian, joined him in this promising work.

No sooner had the new undertaking been advertised in the public papers than a most infamous libel appeared in the *Appenzeller Zeitung*, October 1, 1831, in which scurrilous calumnies and lies were shamefully hurled against Fröbel's character and his institution in Keilhau. Fröbel declared that he considered it unworthy of him to reply to an anonymous article, but since his life and all his doings were open to all the world, he requested that the writer should come forth publicly, should re-issue his charges in the *Rudolstädter Wochenblatt*, as well as in the *National Zeitung der Deutschen*, in Gotha; and, moreover, send a copy of it to the Government in Rudolstadt. Then only would he engage to clear himself of the frivolous charges.

In the same month several articles appeared in the *Aargauer Zeitung*, eulogising Fröbel and Schnyder, and speaking in high terms of Keilhau.

That the wanton attack had completely failed to set the Wartensee public against the undertaking, was soon manifested in a most satisfactory manner by the large number of day-pupils. Sempach and other neighbouring villages also sent a considerable number, but the expected influx of boarders failed; and a serious disappointment this proved to be, inasmuch as the financial exigencies had to be met principally from that source. How far this failure may be attributed to the scandalous article referred to above, or to the secret undermining of hostile priests, will probably never be ascertained.

It is touching to see how faithfully the Keilhau friends stood by their leader. Scanty as were their resources, and all but overwhelming their own anxieties, they still managed to send welcome support; but when in the second year matters did not appear to improve, Barop was commissioned to investigate thoroughly the state of things at Wartensee. Under great personal privations, and as a poor pedlar, he managed to accomplish the long journey on foot. He found the public greatly in favour of the school; the only objection they had to Fröbel and his associates was that they were 'heretics.' The buildings, designed for a palatial residence, were not at all suitable nor efficient in accommodation for a large school, nor was the slightest alteration permitted; so, after careful deliberation, they found that, in the face of the secret sinister influences at work, the school could not hold its own and had better be removed, but whither they knew not.

They still had confidence in the guidance of Him whose work they believed they were accomplishing, and disappointments are, and ever will be among His best and most effectual means of education.

One evening they sat at the village inn, so much absorbed in earnest deliberation that they failed to notice the deep interest with which their conversation was listened to by three strangers, who subsequently introduced themselves as commercial men from Willisau, Canton Luzern, and, with great animation, besought Fröbel to transfer his school to their town. They promised him every assistance; and in a short time a formal application was received, signed by twenty of the leading families, already formed into an association for the promotion of Fröbel's educational schemes.

Fröbel readily consented; the committee procured the grant of the large Government house, and so far the way was made plain. During the interval previous to the opening he visited Keilhau, and also his mother-in-law at Berlin (February, 1833). A most valuable acquisition to the staff of teachers was made in Adolph Frankenberg, who had just finished his theological studies in Göttingen, but on account of the dissolution of the University under King Ernest George was obliged to forego his examination. He joined the friends with heart and soul, proved to be admirably adapted to his position, and henceforth devoted his life to the sacred cause with earnest and indefatigable faithfulness.

Meanwhile the Roman Catholic clergy had left no stone unturned to crush the new project. They had used all their influence in Government circles against Fröbel, and it was not before March that Barop could inform him of final victory. In April the official documents arrived, and Fröbel and his wife repaired to their new destination. The school was opened with thirty-six pupils. The hearty co-operation and the high esteem of the educated classes certainly never flagged; but, bad as the fanatical intolerance of the priests had been at Wartensee, it proved infinitely worse in Willisau. Not only did they prevent boarders from coming, but they excited the mob against them in a most unscrupulous manner. Fröbel and his friends were repeatedly cautioned by kindhearted people not to take their regular walks in the same direction, as their lives were in danger.

They never failed to attend public worship, and did everything they could to make the people forget that they were of a different creed.

Once they assisted at some church festival by conducting the musical part, when, as a singular recognition of their services, a most vehement philippic was hurled against them from the pulpit, and the frightened congregation was exhorted to secure to themselves an everlasting treasure in heaven.

(To be continued.)

Publications Reviewed.

Life, Function, Health. Studies for Young Men. By H. Sinclair Paterson, M.D. London: Hodder and Stoughton.

This is a volume of lectures by a talented writer, on various biological and physiological matters. It really consists of three portions, each containing eight lectures, which were separately published after their delivery before the Young Men's Christian Association.

The first part contains 'Studies in Life'; and discusses the characteristics, origin, varieties, natural history, enemies, and results of life. The author shows throughout a strong religious bias, with which we thoroughly sympathise; but nowhere does he allow this to prevent his clear description of scientific theories, or lead him into rancorous opposition to the theories of those scientific leaders who hold different views from his own. On the contrary, a liberal spirit and a knowledge thoroughly conversant with scientific matters is constantly manifested.

The chapter on the 'Enemies of Life' is particularly interesting from a sanitary standpoint.

The second part discusses 'The Human Body and its Functions.' It is really a popular description of the broad facts and principles of physiology, stated in a thoroughly untechnical and lucid manner, which will be interesting to all. The descriptions of the Commissariat and Intelligence Departments, and what we may venture to name the Sewage Department, are all simple and instructive; while the chapter on the Executive Department, in which the evolution of energy in the body is discussed, ought to be read by all.

The third part consists of 'Health Studies,' and may be regarded as an application of the principles stated in the previous sections to the maintenance of health. Food and appetite, exercise, worry, rest, and sleep are carefully discussed, and many valuable health lessons may be gathered from these chapters. The chapter on 'Fastness' deals carefully and delicately with an important subject, and one on which young men sadly lack advice; while, under the head of 'A Merry Heart,' the influence of mind on body is discussed.

The chapter on 'Disease Germs' contains much useful information, though the division of zymotic diseases into epidemic, endemic, and infectious is by no means logical.

The last chapter on the 'Rational Principles of Medicine' tells us what *not* to expect from doctors, and no one would be gladder than medical men, if the common notion of *specifics*—that, in other words, for every disease there is a remedy, which only needs to be employed after a rule-of-thumb fashion—were completely smashed. Such a notion is derogatory to the true honour of the medical profession, and reduces medical men to the level of quacks. Dr. Paterson uses a happy illustration in reference to this popular delusion, when he says that, in the vulgar mind, diseases are like rats in a house—you require to poison them to get rid of them.

The book has scattered throughout it illustrative anecdotes, which lighten the way. It is clearly printed and well bound. We highly recommend it to all teachers. They will find in it invaluable material for teaching purposes.

Gospel Manual. Grade III. of the 'Mimpriss System of Graduated Simultaneous Instruction.' London: 'The Systematic Bible Teacher' Depository, 67, Paternoster Row.

The fact that this little manual has reached its eighth edition shows the favour which it has deservedly received at the hands of teachers and students. To those who are not practically acquainted with the details of the system on which the book is based, a careful perusal of the introduction—in which an ideal lesson is fully described—will be both interesting and instructive. It may be well to mention that the manual consists of one hundred lessons, which deal with the whole Gospel history, and are carefully harmonised and arranged in chronological order. Each page is divided into three columns, the middle one containing the lesson, compiled from the four Gospels; the first the geographical questions, parallels, lessons, etc., in connection therewith; and the third a series of explanatory notes and illustrative remarks—all evidently arranged by one whose acquaintance with Gospel history is as wide as his knowledge of Sunday-school requirements. The only failing under which the volume labours is the smallness of print necessitated by its present size. If the book were made larger, and the size of type correspondingly increased, we feel sure the change would be welcomed by the greater proportion of its readers.

Sundry Attacks on Private Schools and Strictures Thereon. By Richard W. Hiley, M.A. London: Longmans, Green and Co.

The proximate *raison d'être* of this book seems to have been some disparaging remarks anent private middle-class schools made at the meetings of the National Society for the Advancement of Social Science, in 1875, 1876, and 1883, and also in the columns of the press during the same period. The sweeping nature of these strictures may be gathered from the fact that one speaker described private schools as being 'the speculation of men and women without culture, without elevation of character, often without manners—men who have undertaken to teach without having learned anything'; and another said that any one, 'whatever his qualification, may open a school, and, provided that he can induce parents to believe in him, may conduct it as he pleases, with what assistants he pleases, and with what modicum of real teaching he can or will give. . . . It is on the ignorance and helplessness of the parents that educational quackery thrives.'

In reply to these condemnatory remarks Mr. Hiley writes strongly, and to the purpose. He frankly owns that there are black sheep amongst private schoolmasters as in every other profession, but strongly deprecates the injustice of denouncing the *whole* class for the sins of the few. Then, as some of the most pronounced adverse critics *were* masters of large public schools, he carries the war into the enemies' quarters by pertinently inquiring if public-school education as given in great establishments, such as Rugby and Harrow, is regarded as immaculate by those who have tried it. Mr. Hiley, by advancing the testimony of the Rev. Sidney Smith, Anthony Trollope, and Serjeant Ballantine, conclusively answers this question in the negative. We must refer our readers who are interested in the question of private middle-class schools to the booklet itself for fuller details; but before closing our remarks we would emphasize one point to which Mr. Hiley refers. This point is the tendency in the present day in certain quarters to use the expressions 'adventure' and 'adventurer' in connection with private schoolmasters and their establishments in a way that conveys reproach. Mr. Hiley conclusively proves the absurdity of this practice by showing that those very schools—Harrow, Rugby, and the like, considered to be the very antitheses of private adventure schools—have all the trade aspects which constitute an adventure school inherent in themselves, they being to all intents and purposes but an aggregation of private schools, kept by the various house masters. Mr. Hiley has our sympathies as the defender of a class which numbers amongst its component units some of the most energetic and most advanced practical educationalists of the day.

Swift's 'Gulliver's Travels.' Edited by T. Parry, F.R.G.S. Longman's Modern Series. London: Longmans, Green and Co.

This issue of Swift's celebrated work has been carefully edited and prepared for school use, and being well annotated and illustrated, affords a reading book rather out of the ordinary school run, to be appreciated accordingly.

An Introduction to the Study of Shakspeare and Milton. London and Liverpool: George Philip and Son.

From a memorandum accompanying this volume, we gather that it has been written and arranged with the view of affording teachers an opportunity of introducing their pupils to the study of Shakspeare and Milton in a more comprehensive and systematic manner than is the case when any single play or poem is studied to the exclusion of the rest. The plea is made that, considering the necessarily limited time that can be given to the study of Shakspeare and Milton, even in the best schools, more benefit would be derived from a judicious selection than from the study of any single part. Though we admit there is much truth and force in this statement, we very much doubt if teachers, at any rate, in upper and middle-class schools, are to any great extent free agents in the matter. In those schools the study of Shakspeare or Milton is regulated simply by the particular examination for which the students are being prepared, so that as long as the examination councils of management set single plays and poems, so long will teachers be obliged to confine themselves in a similar manner. We do not wish to imply that in our opinion the study of single plays should be discontinued. We hold quite the reverse, and consider that a lad who has during his school-days carefully gone through two or three plays, is fully prepared in after years to read with intelligence and advantage to himself the remaining works, should he have any inclination so to do.

For schools, however, in which it is possible and advisable to use excerpts, the present volume is admirably adapted, the selections being judiciously made, the notes and critical reviews copious and thorough, and the book being illustrated with numerous wood-cuts.

Dictionary of the Portuguese Language. In two parts:—(1) Portuguese-English; (2) English-Portuguese. By Alfred Elwes. London: Crosby Lockwood and Co.

This, the latest addition to that estimable series of manuals known as the Weale Series, is a thoroughly serviceable volume. The compiler—Mr. Alfred Elwes—has had much experience in similar work, and has evidently kept well in view that idea of utility which is the distinguishing feature of the series. We have pleasure in recommending it as a clearly-printed, and, as far as we have tested it, an accurate dictionary of the Portuguese tongue.

Poynter's South Kensington Drawing Books. Human Figure, Elementary. Books I., II., III., and IV. London: Blackie and Son.

These are the first four books of an elementary series on the human figure, and it would be difficult—if not well-nigh impossible—to devise a more practical and serviceable set. Book I. contains a series of examples of the various parts of the face, based on studies taken from the colossal statue of David, by Michael Angelo; Book II. deals with heads, full-faced and profile; whilst Book III. furnishes numerous examples of hands, and Book IV. of feet. As all the examples have been taken from celebrated statues, illustrative of the highest Greek art, and the drawings have been made under the personal direction of Mr. Edward Poynter, R.A., there is no fear that the student who uses these books will have anything to unlearn in style or treatment.

A Course of Simple Object Lessons for Infants. Second Series. By W. Hewitt, B.Sc. London: Longmans, Green and Co.

This little book contains a series of thirty lessons on subjects carefully selected to suit the capacities of children six or seven years of age. Each lesson is treated in considerable detail, and many of them contain hints for interesting supplementary lessons, which will prove useful either in extending the course, should that be thought necessary, or as substitutes for those lessons which may be considered unsuitable in certain cases. We have pleasure in recommending the little book to the attention of teachers.

The Latin Handbook of Passages set at Civil Service and other Examinations. By W. K. Dalgleish, B.A. London: Longmans, Green and Co.

This handbook is apparently one of a series of open competition handbooks now in preparation under the editorship of W. J. Chetwode Crawley, LL.D., and will, in our opinion, prove of immense service to those teachers whose task it is to prepare candidates in Latin for any of the great open competitions. It contains all the important passages set for many years past at the examinations held by the Civil Service Commission and at the Army Entrance examination, and the book shows abundant evidence in its careful arrangement and attention to detail of being the work of a practical teacher. The indexes at the end, being complete and copious, enable the teacher with very little difficulty to form an estimate of the kind of Latin pieces usually selected for translation at sight at the various examinations.

The Student's Proper Psalms, being Notes, Historical and Explanatory. By the Rev. G. W. Wall, M.A., Incumbent of Bickerstaffe. London: Walter Smith.

Those who desire a concise, interesting, and, we believe, trustworthy manual, explanatory of the Psalms as they are appointed to be read in the service of the Church of England, can hardly do better than procure this volume. The Rev. G. W. Wall is to be congratulated on having produced a work both scholarly and understandable by all—a regrettably rare combination. The notes are concise without baldness, and show abundant evidence of careful and laborious research.

Exercises in Arithmetic. Standards I.-VII. By George Ricks, B.Sc. Lond. 'The Modern School Arithmetics.' London: Cassell and Company, Limited.

This series, up to Standard VII., seems excellently adapted for its intended purpose, being carefully graduated, clearly printed, and serviceably brought out. The examples are very copious and the miscellaneous questions and test exercises at the end of each book are well calculated to emphasize the more important rules, and to serve for examinational purposes. It may be as well, however, to mention that Standard VII. has not been quite altered to suit the requirements of the 1884 Code, as it contains discount and stocks.

Probably, too, in a fresh issue that eyesore to all teachers—the insertion of lists of errata and alterations,—which at present disfigures the last two standards, will be removed. When this has been done, the series may be correctly described as being adapted to the latest requirements of the Code.

Cassell's Modern School Drawing Copies. Adapted to the requirements of the Science and Art Department. First and Second Grade—**Freehand.** London: Cassell and Company, Limited.

These packets of drawing copies deserve commendation, being well printed on stout, serviceable card. Each set contains twelve cards, and, as the latter have examples on both sides, twenty-four drawing-copies. The designs are carefully graduated throughout, and seem admirably adapted to assist the learner in acquiring that facility and accuracy of pencil manipulation which is the desideratum in freehand drawing.

She Stoops to Conquer. Edited by Harold Littledale, B.A. Blackie's School Classics. London: Blackie and Son.

This issue of Goldsmith's humorous play is brought out in the excellent characteristics of the publishing firm whose imprint it bears. In type, arrangement, explanatory notes, paper, and, indeed, in all respects it is an ideal school book.

Readings from the Spectator. Being a selection of papers contributed by Addison. With Notes. London: Blackie and Son.

We have pleasure in recommending this book to the notice of all teachers desiring an interesting and instructive reading-book for the upper standards in their schools. It would be gilding fine gold to say anything in commendation of the subject-matter: suffice it to say that whoever has made the selections understood school requirements and has done his work with care and judgment. The biographical sketch at the commencement of the volume, and the explanatory lists of difficult words, Latin derivatives, etc., at the end, complete a very serviceable addition to school literature.

The Practical Arithmetical Test Cards. By P. Parkington. Wigan: R. Platt. London: Simpkin, Marshall and Co.

This is a set of Cards for Standards II.-VII., in six packets of thirty-six cards each, with two copies of answers to each packet. The compiler's aim has been to provide a set, which, while keeping within the limits of the Code, presents difficulties somewhat greater than the cards in use by the majority of inspectors. As an alternative set they will prove useful, the examples being, as the name indicates, *practical*, but a due admixture of easier examples would have rendered them still more worthy of the name. The set is well printed, and has different coloured cards for each standard.

Code Standard English Grammar. Part V. C. P. Mason, B.A. London: Bell and Son.

This is a very good sequel to the parts of this Grammar already noticed in these columns. It presents all the work required in word-building in Standards V.-VI. in a clear and intelligible form. Numerous examples are provided for practice, and the method indicated of using the Latin prefixes with a number of common roots will, if followed, be sure to add considerably to the intelligence of children using the book.

Sight-Singing for Schools, and Elements of the Theory of Music. National Society's Depository.

In many respects these form an excellent manual of practical and theoretical music for schools and pupil teachers. The sight-singing is based upon the staff notation, and the 'movable doh.' Much, therefore, of what is specially valuable in the sol-fa notation, viz., the principles of 'tonal relationship' and 'mental effect,' is incorporated in this course; but it is much to be regretted that the names used by solfaists, and so universally known, are discarded in favour of others which appear to be a compromise between those of the 'fixed doh' and the 'tonic-solfa.' Thus, instead of *Doh, Ray, Me, Fah, Soh, Lah,* and *Te,* we have the names, *Do, Ra, Me, Fa, So, La,* and *Te.* The course is carefully graduated, and contains a large number of suitable songs and exercises.

The account of the minor scale in its various forms (Chapter IV., Elements of the Theory of Music) can scarcely be regarded as quite satisfactory, nor is the statement that 'the minor scale is formed of the same sounds which constitute the major scale, but taken in a different order,' scientifically correct.

Waiving these points, however, as belonging rather to the theorist than to the practical teacher, the work may be safely recommended as a valuable text-book.

Imperial Handbooks of English History: (*a*) England under the Normans. (*b*) England under the Tudors. By Rev. R. O. Thomas. London: Thomas Murby.

The plan adopted by Mr. Thomas in compiling these handbooks is sure to be appreciated by students preparing for examinations, and any who may use them will feel glad that they have had them introduced to their notice. A brief sketch of each of the reigns of the several periods is first given. The second part is occupied with the principal events, treated at greater length. Under such headings as wars, treaties, laws, commerce, customs, biographical sketches, etc., there is no part of the history on which questions can be formed which has been overlooked. Still further aids in the shape of maps, tables, and summaries have been added, rendering the study easy and pleasant, while an ample assortment of questions from various examinations (pupil teacher, civil service, and university local) provides opportunities for testing the knowledge obtained. We very cordially recommend the volumes.

Chambers's Historical Readers. Books I. and II. London and Edinburgh: W. and R. Chambers.

These are enlarged editions of these popular Readers, and are now perfectly suited to the requirements of the last circular respecting the size of reading-books. They are well-written, suitably illustrated, strongly bound, and properly adapted for the standards for which they have been prepared.

Chambers's Graduated Readers. Book I. London and Edinburgh: W. and R. Chambers.

The requirements of the Department have necessitated changes in most of the reading-books in use. Some additional pages were needed in the Graduated Reader, and the publication of the enlarged edition gives us an opportunity of noticing its merits and suitability for use in Standard I. The book is very attractive in all its features, and a child cannot fail to like the book, with its gems of illustrations, its pretty stories, and pleasant rhymes. Teachers in need of a good reader for Standard I. should see the 'Graduated.'

The Promised Land: A Service of Praise compiled by T. Austin. London: Wesleyan Methodist Sunday School Union; Curwen and Sons.

This 'Service of Song' comprises some excellent hymn-tunes by well-known composers, together with original compositions by the compiler. We are sorry to be obliged to say that the original productions are by no means the best. The accompanied solos are fairly good, but the sanctus, which contains in the third score an unnecessarily doubled leading-note, in addition to consecutive perfect fifths between bass and tenor in stepwise similar motion, and ''Tis the Church triumphant singing,' are weak specimens of four-part harmony.

Carols for Christmas Services. The Children's Home, Bonner Road. Wesleyan Methodist Sunday School Union.

It would be out of place to criticize as a musical composition this little book, containing half-a-dozen carols, with words and music, published at a penny, in aid of the Children's Home. In furtherance of this laudable object, we can only hope that the book will have a wide circulation.

Cornhill Magazine. June, 1884. London: Smith, Elder and Co.

The June issue of this well-known magazine contains much that is fresh and interesting. 'Dr. Greatrex's Engagement' is a striking story of the effect produced upon nervous, highly-strung temperaments by the perusal of medical works on insanity. The article entitled 'My

Arab,' which depicts in simple and unexaggerated language the daily life of the average London *gamin*, will be read with considerable interest, now that the condition of the London poor is attracting so much attention.

Italian Primer, with Exercises. By the Rev. A. C. Clapin, M.A. London: George Bell and Sons.

This concise and well-arranged little book will, if we mistake not, be heartily welcomed by teachers of Italian, and may perhaps encourage many students to take up the language as one of their subjects for examination. The author is already favourably known as a writer of French and German Grammars for school use, and we doubt not that the present work will meet with the same appreciation.

Enunciations of Propositions in Geometrical Conic Sections. By W. H. Besant, M.A., Sc.D., F.R.S. Cambridge: Deighton, Bell and Co.

This book contains the enunciation of the propositions in geometrical conic sections, together with the figures and definitions appertaining to them. The little volume calls for no review save that it is well printed, and the figures drawn with clearness and exactitude.

Gill's New Music for the Code 1883. By R. H. Macartney, A.Mus. T.C.L.

A series of Tests and Schools Songs, arranged in three books. Being printed in both staff and sol-fa notations, these books will be found useful in most schools. The style of printing is excellent, and the absence of the typographical errors which deface so many of the collections of school songs recently produced shows that the books before us have been carefully prepared.

The songs, especially in Part III., are pleasing and melodious, and are set to good standard poetry. We have no hesitation in saying that the teacher will find these songs a valuable addition to the *repertoire* of school music.

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Health and Education at South Kensington.

THE idea of holding an exhibition of the various appliances connected with Health and Education was a happy one, and has already proved to be a great success. At the first glance many failed to see any reason why Education should be included in the programme of this year's display at South Kensington, but a moment's reflection will show how intimately education is connected with the proper appreciation of hygienic laws and appliances. Indeed, the first thought that suggests itself to an intelligent visitor on entering the Health Exhibition is that education alone has rendered such an exhibition possible. A few years ago the public mind was so ill-informed on matters relating to science and sanitation that such a collection of objects as is now to be seen at the exhibition would have attracted no attention. But thanks to the advance in education all along the line the great success of the Fisheries Exhibition seems likely to be surpassed by that of the present year. It is also to a further development of popular education that we must look for an extension of sanitary knowledge among the masses, and for that improvement of the national health which all desire to see accomplished.

An ordinary visitor to the exhibition at the present time (June 21st) would probably fail to see any of the educational exhibits, except those, perhaps, contributed by the enterprising little kingdom of Belgium. Indeed, it cannot be truly said that the educational section of the exhibition is yet open. High up in the gallery of the Albert Hall, remote from the more attractive parts of the exhibition are to be found the stalls of various well-known publishers and school furnishers, and in the Belgian Court is an interesting and unique collection of school-work and school-appliances. But the main part of the educational section is to be shown in the new buildings of the City and Guilds Central Institute, which are now nearly completed. By the time these lines are in the hands of our readers, His Royal Highness the Prince of Wales, the President of the exhibition, will have declared the section open. The great interest taken by the Prince in everything relating to the welfare and education of the people was shown by his presence at the inauguration of the International Juries immediately after his return to England, and by the active, personal interest he has taken in the work of organising the present exhibition. It will therefore not be our aim in the present notice to offer any criticisms on the objects in the education section or on their arrangement, but rather to give a general outline of the character and position of the exhibits already exposed to view.

Entering the building at the main entrance in Exhibition Road the visitor in search of the educational appliances must make his way to the northern side of the gardens, either through the central avenue or by the eastern gallery, until he reaches the great conservatory. He will pass on his way innumerable specimens of stoves, fire-places, and cooking-ranges, and if the day be hot will be glad to pass to the cooler air of the Albert Hall. Having arrived in the corridor, he may, if he has time to spare, take his turn for the lift, by which he will be gratuitously wafted aloft to the higher region dedicated to education. Here the visitor will find sufficient to occupy his attention for many hours. School desks innumerable are there, some so complicated in form and adjustments that we presume they combine the scientific principles of physiology with the discomfort of the scholar. School maps, scientific apparatus, school-books, blackboards, and other heavy articles of school furniture are also here exhibited in bewildering profusion, and, we regret to say, without any arrangement enabling the visitor to make a comparison of the merits of the same class of objects by different makers. Many of the appliances here shown are new, and not a few are successfully designed to improve the health of scholars and teachers. Among the principal exhibitors we notice Hammer, Edwards, Stanford, Northern Educational School Furnishing Company, Educational Supply Association, Gill and Sons, Joseph Hughes, and others. The specimens of single desks are numerous, and are infinitely superior to the so-called dual desks which appear to combine all the disadvantages of expensiveness and inconvenience. We observe that in the present exhibition the marked prices of school apparatus take a much wider range than heretofore, the extension being in both directions, some towards cheapness and others, *e.g.*, the 'University' desks, towards excessive cost.

It is a distinct loss that the educational exhibits of different countries cannot be seen in juxtaposition to each other. For example, it would have been much better if the school desks of all countries had been shown together, and the same is true of the maps and physiological models. It is by comparison only that the relative merits of the various specimens can be properly assessed, and such an arrangement as

we desiderate would have greatly facilitated the work of the jurors. We understand that the obstacle to this better arrangement of exhibits was the desire for each country to keep its contribution to the exhibition intact, and the same difficulty was raised in a less degree by even the English exhibitors.

A rapid and cursory glance at the arrangements in the City and Guilds Institute enables us to say that the teachers and educationalists who intend to visit the building, have a great treat in store. The rooms fitted up by the National Society, the London School Board, the Glasgow School Board, the Christian Brothers, and others, are full of novel and interesting specimens of school books, appliances, and school work. If we mistake not, this part of the exhibition will become highly popular, and will attract during the holidays a large number of practical teachers from all parts of the country.

Arrangements are in progress for holding, in connection with the Exhibition, an International Educational Conference, which is to take place on August 5th and following days. The presence in London of educational experts from all parts of the world will give to this conference a special interest. We hope that by means of this conference, it may be possible to arrive at a more accurate estimate of the comparative position of English and Continental schools, and that the excellencies and defects of foreign systems may be authoritatively noted for the benefit of the country. The following subjects for discussion have been proposed by the Committee of Management of the Conference, of which Lord Reay is Chairman.

1. *Conditions of Healthy Education.*—Under this head may be included—the consideration of the structure, fitting, and equipments of a School; gymnastics, and other physical exercises; the right apportionment of time to different subjects of instruction in schools of various classes; the indirect effect of pictorial or other decoration in improving the taste and cultivating the imagination, and in increasing the scholars' interest in their work.

2. *Infant Training and Teaching.*—(*a*) Kindergarten; (*b*) Instruction generally.—Under this head may be included—the right structure of schools and class rooms for very young children; the apparatus needed for play and for instruction; the exercises, mental or manual, best fitted to awaken the faculties; the distribution of time; pictures, decoration, collections of objects, etc.

3. *Technical Teaching.*—(*a*) Science; (*b*) Art; (*c*) Handicrafts; (*d*) Agriculture; (*e*) Domestic Economy.—Under this head may be included: (*a*) methods of teaching the different branches of physical and of natural science, the equipment of school laboratories, the value of experimental work by pupils, the organisation of evening science classes and of science schools, the connection between the teaching of pure and applied science; (*b*) the teaching of drawing and of colouring as a preparation for designing and decorative work; (*c*) the value of special and general workshop instruction in elementary, higher, and evening schools, the equipment of school workshops; (*d*) the teaching of agricultural science in elementary, in intermediate, and higher schools, in evening science classes, in special colleges, and in the universities, methods of teaching, experimental farms; (*e*) methods of teaching cookery in schools, *e.g.*, by book-lessons, by demonstrative lectures, and in school kitchens.

4. *Teaching of Music in Schools.*

5. *Museums, Libraries, and other Subsidiary Aids to Instruction in Connection with Schools.*—Under this head may be included the means of establishing and managing school libraries; the promotion with the help of the scholars or otherwise, of museums of art and science, illustrative of the local fauna, flora, industry, history, archæology, etc., etc.; School Savings Banks; botanical and other field excursions; visits to picture galleries and museums; voluntary evening classes for singing, recitations, etc.; and generally the means of connecting the influence of the school with home life and self-improvement.

6. *Training of Teachers:*—Under this head will be considered the right professional preparation for Teachers in—(*a*) Elementary; (*b*) Intermediate and Higher; (*c*) Special and Technical Schools.—The relative advantages of training in special institutions and in colleges for general education. Normal colleges: their constitution, conditions of admission, programme of studies. Apprenticeship. Model and practising schools. Universities and their relations to the training of teachers. Professorships and lectureships on education. Examination for diplomas and certificates. Legal recognition of such diplomas and certificates. Registration of teachers.

7. *Inspection and Examination of Schools.*—(*a*) By the State; (*b*) By the universities; (*c*) By other public bodies.

8. *Organisation of Elementary Education.*

9. *Organisation of Intermediate and Higher Education.*

10. *Organisation of University Education.*

11. *Systems of Public Instruction in various Countries.*

It will be seen that many of the subjects proposed for discussion are of the greatest importance to practical teachers. We shall, therefore, hope to give carefully summarised notices of such discussions in the PRACTICAL TEACHER, and to place before our readers during the present year all points of practical usefulness arising from the remarkable display at South Kensington.

Correspondence.

To the Editor of the PRACTICAL TEACHER.

DEAR SIR,—I see that you have sometimes inquiries for the back Nos. of the 'P.T.', now out of print. I should take it as a favour if you would refer any inquirers to me, as I wish to dispose of mine from the commencement to the present month. The first two volumes are well bound in the cases supplied from the office; the rest are in numbers. I am leaving the profession and the country at the end of July, or I should not care to part with what I have found to be the most useful of professional papers, and which I have induced many friends to take in.

I am, yours truly,
W. HOWARD.

Publications Received.

Bell and Sons (G.)—
The Code English Grammar. Part V. By C. P. Mason, B.A.

Bogue (David)—
The House of Lords: An Address by Sir J. Bennett.

Cassell and Co., Limited—
The Modern School Drawing Copies, First and Second Grade Freehand.

Educational Supply Association, The—
Practical Geometry.
Gray's 'Elegy,' with Notes.
Drawing to Scale Test Papers.
'Trades'—The Printer (Mounted).

Grant and Co.—
The New Code, 1884. By R. Gowing. With Notes, etc.

Heywood (John)—
Local Examination History. By Dr. R. S. Pringle.

Hodder and Stoughton—
How Sorrow was Changed into Sympathy. By Mrs. Prentiss.
Guides and Guards into Character Building. By Dr. Payne.

Letts, Son, and Co., Limited—
Letts' Illustrated Household Magazine for June.

Longmans and Co.—
A Course of Simple Object Lessons for Infants. By H. Hewitt, B.Sc.
Longman's Magazine for June.
Selections from Shakspere's 'King John.' By T. Parry, F.R.G.S.

Murby (T.)—
Murby's Scripture Manuals—Judges.
England under the Tudors. By Rev. R. O. Thomas.
England under the Normans. By Rev. R. O. Thomas.

Smith, Elder, and Co.—
The Cornhill Magazine for June.

Swale (T. S.), Widnes—
The Educational Franchise. By J. Hargreaves, F.C.S., F.A.S.

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Passages for Translation

From books not prescribed, set at the June Matriculation Examination of the London University.

1. Cn. Lentulus consul, cum in contione de Magni Pompei nimia potentia quereretur adsensusque ei clara voce universus populus esset, 'adclamate' inquit, 'Quirites, adelamate, dum licet; iam enim vobis impune facere non licebit.'

2. In nemus ire libet, pressisque in retia cervis
Hortari celeres per iuga summa canes,
Aut tremulum excusso iaculum vibrare lacerto
Aut in graminea ponere corpus humo.
Saepe iuvat versare leves in pulvere currus
Torquere et frenis ora fugacis equi.

3. Diogenes Syracusis, cum olera ei lavanti Aristippus dixisset 'si Dionysium adulari velles, ista non esses,' 'immo,' inquit, 'si tu haec esse velles, Dionysium non adularere.'

1. Τῇ μὲν γυναικὶ κάλλιον ἔνδον μένειν ἢ θυραυλεῖν, τῷ δὲ ἀνδρὶ αἰσχιον ἔνδον μένειν ἢ τῶν ἔξω ἐπιμελεῖσθαι.

2. Διδοντος τοῦ Τιθραύστου πάμπολλα δῶρα, εἰ ἀπέλθοι ἐκ τῆς χώρας, ἀπεκρίνατο ὁ Ἀγησίλαος, ὦ Τιθραύστα, νομίζεται παρ' ἡμῖν τῷ ἄρχοντι κάλλιον εἶναι τὴν στρατιὰν ἢ ἑαυτὸν πλουτίζειν, καὶ παρὰ τῶν πολεμίων λάφυρα μᾶλλον πειρᾶσθαι ἢ δῶρα λαμβάνειν.

3. Πολλῶν ταμίας Ζεὺς ἐν Ὀλύμπῳ,
πολλὰ δ' ἀέλπτως κραίνουσι θεοί·
καὶ τὰ δοκηθέντ' οὐκ ἐτελέσθη
τῶν δ' ἀδοκήτων πόρον εὗρε θεός.

Query Column.

RULES.

1. Each correspondent is restricted to *one question*. We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.

2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.

3. ☞ When a pseudonym is adopted it should be written at the end of the query, and the real name and address on a separate piece of paper.

4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.

5. Replies will not be sent through the post.

6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—'*The Query Editor*,' *The Practical Teacher*, *Pilgrim Street*, *Ludgate Hill*, *London*, *E.C.*

Arithmetic.

1. LL.—A tax of 5d. in the pound is paid on a certain sum, and a further tax of 1½ per cent. on the remainder. The sum now remaining is £31 2s. 9d. Find the original sum. (*Scholarship*, 1883.)

Amount left out of £1 after paying first tax = 19s. 7d.;
" " " " " second tax
$= 98\frac{1}{2}$ per cent. of 19s. 7d.
$= \left(\frac{197}{240} \times \frac{197}{200}\right)$£
$= £\frac{38809}{48000}$;

£ £ s. d. £
∴ 38809 : 31 2 9 :: 9600 : Original sum.

197 20
622
12
7473
159

$= \frac{159 \times 40}{197}$£
$= £\frac{6360}{197}$
$= £32\ 5s.\ 8\frac{44}{197}d.$ Ans.

2. INQUISITIVE.—A can beat B in a one hundred yards' race by 5 yards and C by 10 yards; by how many yards will B beat C? (*Edinburgh University Medical Preliminary*, 1884.)

A runs 100 yds. while B runs 95 yds.,
" " " " C " 90 " ;
∴ B " 95 " " C " 90 " ,
18
" " 100 " " C " $\left(\frac{90}{95} \times 100\right)$yds.
19
$= \frac{1800}{19}$ yds.
$= 94\frac{14}{19}$ yds.
∴ B will beat C by $(100 - 94\frac{14}{19})$ yds. $= 5\frac{5}{19}$ yds. in 100 yds.

3. O. H. F.—A model of the earth is made on a globe 30 ft. in radius. Express as the fraction of an inch the height of the highest mountain upon it, taking the earth's diameter as 7,946 miles, and the height of the highest mountain as 29,000 ft. (*Certificate Examination*, 1882.)

Radius of earth = 7946 miles ÷ 2
= 3973 miles;
miles. ft. ft.
∴ 3973 : 30 :: 29000 : Height on globe.

25
∴ Height $= \frac{30 \times 29000 \times 12}{3973 \times 5280}$ in.
137 440
11

$= \frac{220}{1607}$ in.
$= \frac{1}{7}$ in. nearly Ans.

4. M. R. S.—By selling £4500 in the India 5 per cent. stock at $112\frac{1}{2}$, and investing the proceeds in Egyptian 7 per cent. stock, a person finds his income increased by £168 15s. What is the price of the latter stock?

Income in 1st case = 5 per cent. on £4500
= £225
" 2nd " = £225 + £168 15s.
= £$393\frac{3}{4}$;
Amount realised for stock = £$(112\frac{1}{2} \times 45)$
= £$5062\frac{1}{2}$;

£ £ £
∴ $393\frac{3}{4}$: 7 :: $5062\frac{1}{2}$: Price of Egyptian stock.

4 4
1575 2025
315 90
= £90. Ans.

5. GRATEFUL.—A man rows down a river 18 miles in 4 hours with the stream, and returns in 12 hours; find the rate at which he rows, and the rate at which the stream flows. (*Hamblin Smith.*)

Rate per hour with the stream $= \frac{15}{2}$ miles
$= 4\frac{1}{2}$,, ;
,, ,, against ,, $= 1\frac{1}{2}$,, ;
$= 1\frac{1}{2}$,, ;
∴ ,, ,, of rowing $= (4\frac{1}{2} + 1\frac{1}{2})$ miles $\div 2$
$= 3$ miles ;
,, ,, ,, stream $= (4\frac{1}{2} - 3)$ mi'es
$= 1\frac{1}{2}$ miles.

Note.—Perhaps 90 per cent.

6. GENTIL.—If a person has £550 in the 3 per cent. stock at $81\frac{1}{4}$, and sell the same for $90\frac{3}{8}$, and with the proceeds buy $3\frac{1}{2}$ per cent. stock at $105\frac{1}{2}$, does he gain or lose in income by the transaction? (*Bradlake.*)

Income in 1st case = 3 per cent. on £550
= £16 10s. :

£ £ £
$105\frac{1}{2}$: $90\frac{3}{8}$ :: 550 : Stock in 2nd case.

$$= \left(\frac{3}{\frac{211}{4}} \times \frac{550}{1} \times \frac{2}{\frac{361}{7}}\right) £$$

$$= \frac{2200}{7} £ ;$$

Income in the 2nd case = $3\frac{1}{2}$ per cent. on $£\frac{2200}{7}$

$$= \left(\frac{3300}{7} \times \frac{7}{200}\right) £$$

= £16 10s.

∴ Income is the same in both cases.

Note.—Reckoning brokerage in each transaction.

£ £ £
106 : $90\frac{1}{8}$ :: 550 : Stock in 2nd case.

$$= \frac{725 \times 550}{106 \times 8} £ ;$$

Income in 2nd case $= \left(\frac{725 \times 550}{106 \times 8} \times \frac{7}{200}\right) £$

$$= \frac{55825}{3392} £$$

= £16 9s. $1\frac{81}{113}$d. ;

∴ Difference in income = (£16 10s. − £16 9s. $1\frac{81}{113}$d.) decrease
= $10\frac{32}{113}$d. decrease.

7. J. EDWARDS.—A piece of metal weighing 12 cwt. 60 lbs. has been formed by compounding three metals in quantities, which by measure are as 5 : 3 : 2, but the weights of equal volumes of them would be as 7 : 11 : 13. What weight of each of the component metals has been used?—(*Lower Division*, October, 1883.)

Weights of the three metals are as,
5 × 7 : 3 × 11 : 2 × 13 ;
As, 35 : 33 : 26 ;
35 + 33 + 26 = 94 ;
∴ Weight of 1st metal = $\frac{35}{94}$ of 12 cwt. 60 lbs.

$$= \frac{35 \times 1302}{94} \text{ lbs.}$$

$$= \frac{45570}{47} \text{ lbs.}$$

$$= 969\frac{27}{47} \text{ lbs.}$$

= 4 cwt. $74\frac{27}{47}$ lbs. ;

,, 2nd ,, $= \frac{33 \times 702}{47}$ lbs.

$$= \frac{23166}{47} \text{ lbs.}$$

$$= 492\frac{42}{47} \text{ lbs.}$$

= 4 cwt. $44\frac{42}{47}$ lbs. ;

,, 3rd ,, $= \frac{26 \times 702}{47}$ lbs.

$$= \frac{18252}{47} \text{ lbs.}$$

$$= 388\frac{16}{47} \text{ lbs.}$$

= 3 cwt. $52\frac{16}{47}$ lbs.

8. J. E.—A sum of money doubles itself at compound interest in 4 years; how many fold will it be increased in 16 years?

Amount in 4 years = Twice original sum ;
,, 8 ,, = 4 times ,, ,, ;
,, 12 ,, = 8 ,, ,, ,, ;
,, 16 ,, = 16 ,, ,, ,, .

Note.—Perhaps 95 per cent.

9. MAGISTER.—Four horses and 6 cows together find sufficient grass on a certain field; and 7 cows eat as much as 9 horses; what must be the size of a field relatively to the former, which will support 18 horses and 9 cows? (*Barnard Smith.*)

9 horses eat as much as 7 cows,
∴ 4 ,, ,, ,, $\frac{7 \times 4}{9}$ cows
$= 3\frac{1}{9}$ cows,
4 horses and 6 cows ,, ,, $9\frac{1}{9}$ cows ;
18 horses ,, ,, 14 cows,
18 horses and 9 cows ,, ,, 23 cows ;
∴ Second field : First field :: 23 : $9\frac{1}{9}$,
:: 207 : 82.

10. ROGO.—The capital of a trading company consists of 4000 A shares of £80 each, and 2000 B shares of £25 each; in dividing the profits, 5 per cent. of the amount of each share is first paid, and then the remainder, if any, is divided equally amongst the shareholders. The profits of the undertaking in one year were £34,853 12s. $6\frac{1}{2}$d.; how much would be paid to the holder of an A share; and how much to the holder of a B share?—(*1st Stage Mathematics*, 1883.)

Total capital = (£80 × 4000) + (£25 × 2000)
= £320,000 + £50,000
= £370,000 ;
5 per cent. on £370,000 = £18,500 ;
(£34,853 12s. $6\frac{1}{2}$d. − £18,500) ÷ 6000
= £16,353 12s. $6\frac{1}{2}$d. ÷ 6000
= £2 14s. $6\frac{1111}{12000}$d. ;
∴ Holder of an A share receives 5 per cent. of £80
+ £2 14s. 6d.
= £4 + £2 14s. 6d.
= £6 14s. 6d. ;
Holder of a B share receives 5 per cent. of £25
+ £2 14s. 6d.
= £1 5s. + £2 14s. 6d.
= £3 19s. 6d.

11. CUPIDITAS.—Two towns on a uniformly-flowing river are 27 miles apart; a steamboat takes an hour and a half on its down trip from one town to the other, and a row-boat three hours. The steamboat returns against the stream in one-tenth of the time that the row-boat takes. Required the velocity of the river and speed of boats in still water.

Rate per hour of steamboat with the stream
= 27 miles ÷ $1\frac{1}{2}$ = 18 miles ;
Rate per hour of row-boat with the stream
= 27 miles ÷ 3 = 9 miles ;
Rate of steamboat − Rate of river
= 10 times (Rate of row-boat − Rate of river),
∴ (18 miles − Rate of river) − Rate of river
= 10 times {(9 miles − Rate of river) − Rate of river},
18 miles − Twice rate of river = 10 times (9 miles
− Twice rate of river),
18 miles − Twice rate of river = 90 miles
− 20 times rate of river,
20 times rate of river − Twice rate of river
= 90 miles − 18 miles,
18 times rate of river = 72 miles,
∴ Rate of river per hour = 4 miles.
Rate of steamboat per hour in still water = (18 − 4) miles
= 14 miles ;
,, row-boat ,, ,, = (9 − 4) miles
= 5 miles.

Note.—The other query is a question in mensuration. You will find two methods of solution in our issue for May, 1882.

12. TUTUS DUM RECTUS.—If the year of the planet Mercury were exactly 87, that of Venus 225, and of the Earth 365 of our days, how many of our years would intervene between any two occasions on which the three planets would appear to a spectator from the sun to be in a straight line? (*Sonnenschein.*)

3 | 87, 225, 365
5 | 29, 75, 365
29, 15, 73
∴ L.C.M. = 3 × 5 × 29 × 15 × 73 ;

$$\therefore \text{ No. of years} = \frac{3\times5\times29\times15\times73}{365}$$
$$= 3\times29\times15$$
$$= 1,305. \text{ Ans.}$$

13. WELSHMAN.—A corn-merchant bought 121 quarters of wheat, and he sells it so as to gain 17½ per cent. on 26 quarters, and 13 per cent. on the remaining quantity, having previously tried to sell the whole at a uniform advance of 15 per cent., which would have brought him £4 5s. more than he actually received. What did the wheat cost him per quarter? (*Colenso.*)

Suppose cost price were £100 per quarter;
Then profit would have been £{(17½ × 26) + (13 × 95)}
= £(455 + 1235)
= £1690;

If sold at a uniform advance of 15 per cent., profit would have been £(15 × 121)
= £1815;
Difference of profits = £1815 − £1690
= £125;

£ £ s. £
∴ 125 : 4 5 :: 1690 : Cost price per qr.
8 20 4
85
17

= 68s.
= £3 8s. Ans.

14. X. Y. Z.—A person buys an article and sells it so as to gain 5 per cent. If he had bought it at 5 per cent. less and sold it for 1s. less, he would have gained 10 per cent. Find the cost price. (*Brook Smith.*)

Suppose cost price of the article were £100;
Then selling price would have been £105;
If it had been bought at 5 per cent. less, cost price would have been £95;
If sold at a profit of 10 per cent. on £95, selling price would have been
£95 + £9 10s. = £104 10s.;
Difference between the two selling prices
= £105 − £104 10s.
= 10s.;
For difference of 10s. cost price would be £100,
∴ ,, ,, 1s. ,, ,, £10.

15. CAER GWENT.—A person buys tea at 6s. a lb., and also some at 4s. a lb. In what proportions must he mix them, so that, selling his tea at 5s. 3d. a lb., he may gain 20 per cent. on each lb. sold? (*Barnard Smith.*)

Cost price of mixture = 5s. 3d. × 120/105
= 6/5 of 5s. 3d.
= 4s. 4½d.;

Loss on 1st kind at this price = 6s. − 4s. 4½d.
= 1s. 7½d.
Gain on 2nd ,, ,, = 4s. 4½d. − 4s.
= 4½d.;

d. s. d.
∴ Quantity at 6s. : Quantity at 4s. :: 4½ : 1 7½,
:: 9 : 39,
:: 3 : 13.

Note.—Perhaps 70 per cent.

16. A. M. (SOUTHAMPTON.)—A man has stock in the 3½ per cents. which brings him in £43 15s. a year. He sells out ⅞ of the whole at 112½, and invests the proceeds in railway debentures at 128¾. How much per cent. must the dividend of the debentures be, in order that his annual income may be diminished by 10s. 11½d., no brokerage being charged for the sale of the stock, but ½ per cent. being charged for the purchase of the debentures? (*Excise Exam.*, November, 1881.)

⅛ of income = ⅛ of £43 15s. = £8 15s.;
£8 15s. − 10s. 11½d. = £8 4s. 0¼d.;

£ £ £
3½ : 8¾ :: 100 : Stock sold out.
2 4
7 35
5

= £250.

£ £ £
175 : 112½ :: 250 : Amount of Railway Debentures.
8
1400
7

$$= \frac{7\times125}{4}\text{£}$$
$$= \text{£}218\tfrac{3}{4}.$$

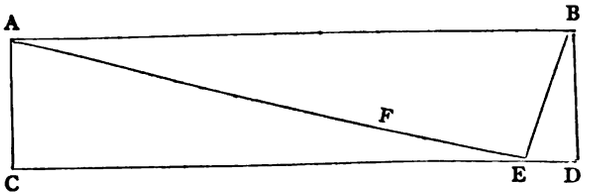
£ £ £ s. d.
∴ 218¾ : 175 :: 8 4 0¾ : Dividend per cent. of debentures.
4 4 4
875 32 16 3
35 4
131 5 0
20
2625
75
= £3 15s.

∴ Dividend of Debentures = 3¾ per cent.

Note.—Your writing is very good, and we believe it will obtain full marks at examinations.

Algebra.

1. AJAX—A lane runs parallel to the firing point and target of a rifle range, and is 200 yards from it. From the firing point to the target is 1,500 yards. At what distance from the end of the lane will a person hear the report of the gun and the clang of the bullet on the target simultaneously, the pace of the bullet compared with the pace of sound being as 4 : 3?



Let A represent the firing-point, B the target, and CD the lane (C being the end of the lane);
Also let E denote the position of the person hearing the report of the gun and the clang of the bullet on the target simultaneously;
When the bullet strikes the target the sound of the report has travelled ¾ of 1500 yds. = 1125 yds.;
Let A F represent this distance, and therefore the distance FE = the distance BE;

Let x = the distance F E or E B in yds.
And let y = ,, E D in yds.;
$BE^2 = ED^2 + DB^2$, (I. 47)
$AE^2 = EC^2 + CA^2$;
$\therefore$ (1) $x^2 = y^2 + (200)^2$
(2) $(1125+x)^2 = (1500-y)^2 + (200)^2$

(1) $x^2 - y^2 = 40000$
(2) $1265625 + 2250x + x^2 = 2250000 - 3000y + y^2 + 40000$

(1) $x^2 - y^2 = 40000$
(2) $x^2 - y^2 + 2250x + 3000y = 1024375$

$$2250x + 3000y = 984375$$
$$6x + 8y = 2625$$
$$\therefore x = \frac{2625-8y}{6}.$$

$$(1)\ \left(\frac{2625-8y}{6}\right)^2 - y^2 = 40000$$
$$6890625 - 42000y + 64y^2 - 36y^2 = 1440000$$
$$28y^2 - 42000y = -5450625$$
$$y^2 - 1500y = -\frac{5450625}{28}$$
$$y^2 - 1500y + (750)^2 = 562500 - \frac{5450625}{28}$$
$$= \frac{15750000 - 5450625}{28}$$
$$= \frac{10299375}{28}$$
$$= 367834{\cdot}8214\ldots$$
$$y - 750 = \pm 606{\cdot}49\ldots$$
$$y = 750 \pm 606{\cdot}5 \text{ (nearly)}$$
$$\therefore y = 1356{\cdot}5, \text{ or } 143{\cdot}5.$$

$\therefore$ Distance ED = 143·5 yds.,
And ,, CE = (1500 − 143·5) yds.
= 1356·5 yds. Ans.

2. J. E. B.—A and B can do a piece of work in m days; A works n days alone, when B joins him, and both together finish the work in p days more; how long would either require to do it singly? (*Scholarship*, 1880.)

First Solution:—

Let x = time A can do the work in days,
And ,, y = ,, B ,, ,, ,, ;

Then (1) $\frac{1}{x}+\frac{1}{y}=\frac{1}{m}$
(2) $\frac{n}{x}+\frac{p}{m}=1$

(2) $\frac{n}{x}=1-\frac{p}{m}$
$=\frac{m-p}{m}$
$\frac{x}{n}=\frac{m}{m-p}$
$\therefore x=\frac{mn}{m-p}$.

(1) $\frac{1}{x}+\frac{1}{y}=\frac{1}{m}$
$\frac{m-p}{mn}+\frac{1}{y}=\frac{1}{m}$
$\frac{1}{y}=\frac{1}{m}-\frac{m-p}{mn}$
$=\frac{n-m+p}{mn}$
$\therefore y=\frac{mn}{n-m+p}$.

$\therefore$ A can do it alone in $\frac{mn}{m-p}$ days,
B ,, ,, $\frac{mn}{n-m+p}$ days.

Second Solution:—

A and B can do the work in m days,
$\therefore$,, ,, ,, in one day $\frac{1}{m}$ of the work,
,, ,, ,, ,, p days $\frac{p}{m}$,, ,, ;
$\therefore$ A does in n days $\left(1-\frac{p}{m}\right)$ of the work
$=\frac{m-p}{m}$,, ,,
,, ,, 1 day $\frac{m-p}{mn}$,, ,,
$\therefore$ A can do the work in $\frac{mn}{m-p}$ days;
B can do in 1 day $\left(\frac{1}{m}-\frac{m-p}{mn}\right)$ of the work
$=\frac{n-(m-p)}{mn}$,, ,,
$=\frac{n-m+p}{mn}$,, ,,
$\therefore$ B can do the work in $\frac{mn}{n-m+p}$ days.

3. CYCLOPS.—Solve:—

$x+\frac{1}{y}=5\frac{1}{2}$
$y+\frac{1}{x}=2\frac{1}{6}$

(1) $x+\frac{1}{y}=5\frac{1}{2}$
(2) $y+\frac{1}{x}=2\frac{1}{6}$

(1) $\frac{xy+1}{y}=\frac{11}{2}$
(2) $\frac{xy+1}{x}=\frac{13}{6}$

Dividing (1) by (2)}

$\frac{x}{y}=\frac{3}{5}$
$\therefore x=\frac{5y}{2}$.

(1) $\frac{5y}{2}+\frac{1}{y}=\frac{11}{2}$
$5y^2+2=11y$
$5y^2-11y=-2$
$y^2-\frac{11y}{5}=-\frac{2}{5}$
$y^2-\frac{11y}{5}+(\frac{11}{10})^2=\frac{121}{100}-\frac{2}{5}$
$=\frac{121-40}{100}$
$=\frac{81}{100}$
$y-\frac{11}{10}=\pm\frac{9}{10}$
$y=\pm\frac{9}{10}+\frac{11}{10}$
$\therefore y=2$, or $\frac{1}{5}$.
$x=\frac{5y}{2}$
$\therefore x=5$, or $\frac{1}{2}$.
$\therefore x=5, y=2$;
or, $x=\frac{1}{2}, y=\frac{1}{5}$.

4. ERO.—A sum of £19,950 if invested in the 4 per cents. would give an annual income of £8 8s. more than if invested in the 3 per cents. If, however, each stock were 1 per cent. higher in price, the former would give £9 17s. 11d. more. What was the price of each stock? (*Cambridge Junior Local*, 1883.)

Let x = Price of the 4 per cents.,
and ,, y = ,, ,, 3 ,, ;

Then, (1) $\frac{19950\times4}{x}-\frac{19950\times3}{y}=\frac{42}{5}$
(2) $\frac{19950\times4}{x+1}-\frac{19950\times3}{y+1}=\frac{47}{5}\frac{5}{8}$

(1) $\frac{1900}{x}-\frac{1425}{y}=\frac{1}{5}$
(2) $\frac{168}{x+1}-\frac{126}{y+1}=\frac{1}{24}$

(1) $5(1900y-1425x)=xy$
(2) $48(168y+168-126x-126)$
$=(x+1)(y+1)$
$48(168y-126x+42)=xy+x+y+1$
$8064y-6048x+2016=xy+x+y+1$
$8063y-6049x+2015=xy$
$\therefore 9500y-7125x=8063y-6049x+2015$
$1437y=1076x+2015$
$\therefore y=\frac{1076x+2015}{1437}$

(1) $\frac{1076x+2015}{1437}\times9500-7125x=\frac{(1076x+2015)x}{1437}$
$10222000x+19142500-10238625x=1076x^2+2015x$
$1076x^2+2015x+16625x=19142500$
$1076x^2+18640x=19142500$
$269x^2+4660x=4785625$
$x^2+\frac{4660x}{269}+(\frac{2330}{269})^2=\frac{4785625}{269}+\frac{5428900}{269^2}$
$=\frac{1287333125+5428900}{269^2}$
$=\frac{1292762025}{269^2}$
$x+\frac{2330}{269}=\frac{\pm35955}{269}$
$x=\frac{\pm35955-2330}{269}$
$=\frac{33625}{269}$, or $-\frac{38285}{269}$
$\therefore x=125$, or $-\frac{38285}{269}$.

$\therefore$ Price of the 4 per cents. = £125;
,, 3 ,, $=\frac{(1076\times125)+2015}{1437}$ £
$=\frac{134500+2015}{1437}$ £
$=\frac{136515}{1437}$ £
$=$ £95.

5. T. ALDOUS.—If x^2+ax+b and x^2+cx+d have a common measure of the form of $x+e$, show that $e=\frac{b-d}{a-c}$. (*Scholarship*, 1880.)

If $x+e$ measure x^2+ax+b and x^2+cx+d, it will also measure their difference;

$\therefore$ $x+e$ will measure $x^2+ax+b-(x^2+cx+d)$,
" " " $x^2+ax+b-x^2-cx-d$,
" " " $ax-cx+b-d$,
" " " $(a-c)x+b-d$,
" " " $x+\frac{b-d}{a-c}$;

$\therefore$ $e=\frac{b-d}{a-c}$.

Note.—(1) You have worked the other question correctly, and your reasoning is sufficiently explicit, but there are *numerous* ways of arranging the digits. (2) With great diligence you might master the two languages in the time: *Dr. Smith's* 'Principia Latina,' Part I.; *De Fivas's* 'French Grammar.' (3) We believe your writing will obtain full marks at the Scholarship Examination; it is *very good*.

6. ST. HELENA.—Solve:—

$$\frac{3-2x}{1-2x}-\frac{2x-5}{2x-7}=1-\frac{4x^2-1}{7-16x+4x^2}.$$ (*Todhunter.*)

$$\frac{3-2x}{1-2x}-\frac{2x-5}{2x-7}=1-\frac{4x^2-1}{7-16x+4x^2}$$
$$\frac{3-2x}{1-2x}-\frac{5-2x}{7-2x}=\frac{7-16x+4x^2-4x^2+1}{7-16x+4x^2}$$
$$\frac{(3-2x)(7-2x)-(5-2x)(1-2x)}{(1-2x)(7-2x)}=\frac{8-16x}{7-16x+4x^2}$$
$$\frac{21-20x+4x^2-5+12x-4x^2}{7-16x+4x^2}=\frac{8-16x}{7-16x+4x^2}$$
$$16-8x=8-16x$$
$$16x-8x=8-16$$
$$8x=-8$$
$$\therefore\ x=-1.$$

7. SOLICITOR.—If x, y, z be the p^{th}, q^{th}, and r^{th} terms of a Harmonical Progression—show that

$$(r-q)yz+(p-r)xz+(q-p)xy=0.$$

Let a denote the 1st term, and d the difference.

$$\therefore\ \frac{1}{x}=a+(p-1)d,$$
$$\frac{1}{y}=a+(q-1)d,$$
$$\frac{1}{z}=a+(r-1)d;$$
$$\frac{1}{x}-\frac{1}{z}=(p-r)d,$$
$$\frac{1}{z}-\frac{1}{y}=(r-q)d,$$
$$\frac{1}{y}-\frac{1}{x}=(q-p)d;$$
$$z-x=(p-r)xzd,$$
$$y-z=(r-q)yzd,$$
$$x-y=(q-p)xyd,$$
Adding} $0=(p-r)xzd+(r-q)yzd+(q-p)xyd,$
$$(r-q)yz+(p-r)xz+(q-p)xy=0.$$

8. BLACKBIRD.—If the H. M. between each pair of the numbers a, b, c be in A. P., then b^2, a^2, c^2 will be in H. P.; and if the H. M. be in H. P., b, a, c will be in H. P.

H. M. $=\frac{2ab}{a+b}$, $\frac{2bc}{b+c}$, $\frac{2ca}{c+a}$; (Arithmetical Progression.)

$$\therefore\ \frac{2bc}{b+c}-\frac{2ab}{a+b}=\frac{2ca}{c+a}-\frac{2bc}{b+c}$$
$$\frac{bc}{b+c}-\frac{ab}{a+b}=\frac{ca}{c+a}-\frac{bc}{b+c}$$
$$\frac{abc+b^2c-ab^2-abc}{(b+c)(a+b)}=\frac{abc+ac^2-bc^2-abc}{(b+c)(c+a)}$$
$$\frac{b^2(c-a)}{a+b}=\frac{c^2(a-b)}{c+a}$$
$$b^2(c^2-a^2)=c^2(a^2-b^2)$$
$$b^2c^2-a^2b^2=a^2c^2-b^2c^2$$
$$2b^2c^2=a^2b^2+a^2c^2$$
$$\frac{2}{a^2}=\frac{1}{c^2}+\frac{1}{b^2}$$
$$\frac{1}{a^2}-\frac{1}{b^2}=\frac{1}{c^2}-\frac{1}{a^2};$$

$\therefore$ b^2, a^2, c^2 are in Harmonical Progression.

Again H. M. $=\frac{2ab}{a+b}$, $\frac{2bc}{b+c}$, $\frac{2ca}{c+a}$; (Harmonical Progression)

$\therefore$ $\frac{a+b}{2ab}$, $\frac{b+c}{2bc}$, $\frac{c+a}{2ca}$; (Arithmetical Progression)

$$\therefore\ \frac{b+c}{2bc}-\frac{a+b}{2ab}=\frac{c+a}{2ca}-\frac{b+c}{2bc}$$
$$\frac{b+c}{bc}-\frac{a+b}{ab}=\frac{c+a}{ca}-\frac{b+c}{bc}$$
$$\frac{1}{c}+\frac{1}{b}-\left(\frac{1}{b}+\frac{1}{a}\right)=\frac{1}{a}+\frac{1}{c}-\left(\frac{1}{c}+\frac{1}{b}\right)$$
$$\frac{1}{c}+\frac{1}{b}-\frac{1}{b}-\frac{1}{a}=\frac{1}{a}+\frac{1}{c}-\frac{1}{c}-\frac{1}{b}$$
$$\frac{1}{c}-\frac{1}{a}=\frac{1}{a}-\frac{1}{b};$$

$\therefore$ b, a, c are in Harmonical Progression.

9. JACOBUS.—Solve:

$$\frac{\sqrt{a+x}-\sqrt{a-x}}{\sqrt{a+x}+\sqrt{a-x}}=b.$$ (*Scholarship*, 1880.)

$$\frac{\sqrt{a+x}-\sqrt{a-x}}{\sqrt{a+x}+\sqrt{a-x}}=\frac{b}{1}$$

Denominator + Numerator / Denominator − Numerator,

$$\frac{2\sqrt{a+x}}{2\sqrt{a-x}}=\frac{1+b}{1-b}$$
$$\frac{\sqrt{a+x}}{\sqrt{a-x}}=\frac{1+b}{1-b}$$

Squaring,

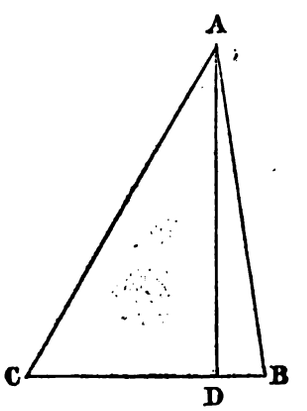
$$\frac{a+x}{a-x}=\frac{1+2b+b^2}{1-2b+b^2}$$

Numerator − Denominator / Numerator + Denominator,

$$\frac{2x}{2a}=\frac{4b}{2+2b^2}$$
$$\frac{x}{a}=\frac{2b}{1+b^2}$$
$$\therefore\ x=\frac{2ab}{1+b^2}$$

Note.—Perhaps 90 per cent.

10. TEACHER.—Let A and B be two stations, and C the terminus of two lines AC and BC, and let angle at C be one o 60°. The perimeter of figure is 200 miles.



A train starting from A arrives at C in the same time as one starting from B. If the train starting from A travel by way of B to C, it takes 3 hours; and if the train starting from B go by way of A to C, it goes in 6 hours. Determine length of sides.

Let x = Distance AB in miles,
" y = " BC " ,
and " z = " AC " ;
Rate of 1st train : Rate of 2nd train :: $z : y$;
Also " : " :: $x+y : \frac{1}{2}(x+z)$;

$$\therefore z : y :: x+y : \tfrac{1}{2}(x+z)$$
$$\tfrac{1}{2}z(x+z)=y(x+y)$$
$$\underline{z(x+z)=2y(x+y)}.$$

Again, $AB^2=BC^2+AC^2-2BC.CD$, (II. 13.)
Now, angle ACB = 60°; ∴ Angle CAD = 30°;
Wherefore triangle ACD is half an equilateral triangle;

$$\therefore CD=\tfrac{1}{2}AC.$$
$$\therefore x^2=y^2+z^2-\left(2y\times\frac{z}{2}\right)$$
$$=\underline{y^2+z^2-yz}.$$

Then,
$$\left.\begin{array}{ll}(1)\ x+y+z=200\\(2)\ x^2-y^2-z^2+yz=0\\(3)\ z(x+z)=2y(x+y)\end{array}\right\}$$
$$(2)\ x^2-y^2-z^2+yz=0$$
$$(x^2-y^2-z^2-2yz)+3yz=0$$
$$(x+y+z)(x-y-z)+3yz=0$$

Substituting from (1)
$$200(x-y-z)+3yz=0$$
$$x-y-z=-\frac{3yz}{200}$$
$$(200-y-z)-y-z=-\frac{3yz}{200}$$
$$200-2y-2z=-\frac{3yz}{200}$$
$$\underline{400y+400z-3yz=40{,}000.}\quad(4)$$

(3) $$z(x+z)=2y(x+y)$$
$$z(200-y-z+z)=2y(200-y-z+y)$$
$$z(200-y)=2y(200-z)$$
$$200z-yz=400y-2yz$$
$$\underline{400y-200z-yz=0.}\quad(5)$$

$$\left.\begin{array}{ll}(4)\ 400y+400z-3yz=40{,}000\\(5)\ 1200y-600z-3yz=0\end{array}\right\}$$
$$-800y+1000z=40{,}000$$
$$5z-4y=200$$
$$\therefore \underline{z=\frac{4y+200}{5}}$$

Substituting this value of z in (5):—

$$400y-200\left(\frac{4y+200}{5}\right)-y\left(\frac{4y+200}{5}\right)=0$$
$$400y-40(4y+200)-\frac{4y^2}{5}-40y=0$$
$$360y-160y-8000-\frac{4y^2}{5}=0$$
$$\frac{4y^2}{5}-200y=-8000$$
$$y^2-250y=-10{,}000$$
$$y^2-250y+(125)^2=15{,}625-10{,}000$$
$$=5625$$
$$y-125=\pm75$$
$$y=\pm75+125$$
$$\therefore \underline{y=200,\text{ or }50.}$$

The value 200 is inapplicable.

$$\therefore \underline{y=50.}$$
$$z=\frac{4y+200}{5}=\tfrac{4}{5}\tfrac{0}{0}=80;$$
$$\underline{x=200-y-z=200-130=70.}$$

∴ Sides are 70, 80, and 50 miles.

General.

1. DUBITUM.—There is a translation in *Bohn's Series*, and also literal translations by Dr. Giles and Kelly.

2. A. S. M.—*Rushbrook's* 'First Greek Reader' is published by Messrs. Macmillan and Co., at 3s. 6d.

3. DESIROUS.—We cannot find 'King Robert' *with music*. The piece is in many collections of poetry.

4. SELF-HELPER may gain 'help' from *M'Laren's* 'Gymnastic Exercises,' Longmans, 2s.

5. RENEZEBE TONNEL.—
(*a*)

Sentence.	Kind of Sent.	Subject.	Predicate.	Object.	Extension.
O Heaven!		*Nominative Exclamatory*			
(*a*)					
That there were but a mote in yours, a grain, a dust, a wandering hair, any annoyance in that precious sense.	Noun sent. obj. to the sent. 'I wish.'	[That] a a mote, a grain, a dust, a wandering hair, any annoyance in that precious sense	were but there in yours		
(*b*)					
Then your vile intent must needs seem horrible [to you] feeling	P. S. co-ordinate with '*I wish*.'	your vile intent	must needs seem horrible [to you] feeling		then (time)
(*c*)					
What small things are boisterous there.	Noun sent. to *feeling* in (*b*)	What small things	are boisterous there		

(*b*) Your small-hand is very good. Your text-band is not so good, some of the curves being imperfectly formed. The capital is the poorest letter.

6. WM. AGER.—There is no reason whatever to believe that bad answering on Latin or French causes loss of marks on the other subjects.

7. DOROTHY.—Your writing wants firmness. It has the excellent quality of legibility; percentage about 75. Dont write *yours* with an apostrophe.

8. MACBETH.—The entrance fee is not uniform, but it includes instruction, food, and lodging. Write to the secretary of the College you would like to enter, and you will receive all the information you require.

9. CAITHNESSIAN.—We think you will be allowed to sit. Apply. Your writing is not good. It is uneven; some of the letters are formed well, some badly. It might carry 60 per cent.

10. ANXIOUS.—You have the query column at disposal. We fear what you want would require too much space. The number who need the help you speak of is now much smaller than it used to be.

11. ALEXANDER.—Small books; 'History of Greece,' 1s.; and History of Rome, 1s., in the series of Primers by Macmillan; larger books, *Smith's* 'Smaller Greek and Roman Histories,' 3s. 6d. each (Murray); also *Smith's* 'Histories of Greece and Rome,' 6s. each (Murray). The small-hand is good, worth perhaps 75; the text-hand is poor, would not get more than half the marks obtainable.

12. ASPIRANT.—*Dr. Casey's* 'Euclid' is published by Longmans, Green and Co.; Elements, 4s. 6d.; Sequel, 3s. 6d.

13. VERITAS.—What subject do you refer to, and what progress have you made in it already?

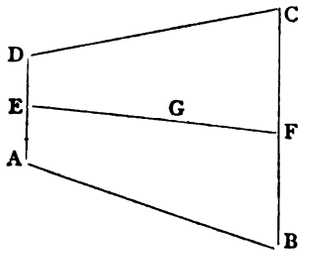
14. REFORM.—We should think 85.

15. ITHON.—It is excellent as to legibility, but it needs finish. The strokes are ragged, the curves are not graceful. There is no arithmetic in the 2nd year's course. If arithmetic is taken it must be the first year's paper.

16. TROUBLED ONE.—The questions set to the first and second years' students are published every year, and may be obtained at the Government Offices, Harding Street, Fleet Street, E.C. The price is 6d.

17. M. H.—You have worked the question *correctly*, and the answer is 10 per cent. loss. According to the rate of exchange (25 francs 20 centimes for £1) the value of a napoleon is 15s. $10\frac{1}{11}$d. and not 15s. 8d.

18. A PUZZLED ONE.—The following is the rule for finding the centre of gravity of a trapezoid :—



Let ABCD be a trapezoid, AD being parallel to BC. Bisect AD, BC in E, F, and join E, F.

Let G denote the centre of gravity of the trapezoid.

$$\text{Then, FG} = \frac{\text{EF}}{3} \cdot \frac{2\text{AD} + \text{BC}}{\text{AD} + \text{BC}},$$

$$\text{Or, EG} = \frac{\text{EF}}{3} \cdot \frac{2\text{BC} + \text{AD}}{\text{BC} + \text{AD}}.$$

19. CUPIDUS DISCENDI.—The solution of your query appeared in our issue for April, 1884.

20. T. HARRIS.—Your query was solved in our issue for August, 1882.

21.—CANDIDATE.—Irregular as to size, neither straight nor symmetrical, and joinings wretchedly bad. 65.

22. LADY MACBETH.—All the long strokes require straightening; the length of stroke is also irregular. Get Mulhaüser's system, and study it. See 35.

23. CLERK OF THE HOUSE.—It has some excellent characteristics. The letters *e*, *r*, and *g* should conform to the recognised type.

24. THE CAULD LAD.—Small hand 80, large 60.

25. X.—Your writing is of a good, useful order for teaching purposes. 80.

26. BEAUPÈRE.—The large hand is decidedly too upright; it should rest at an angle of 60° with the horizontal. The small hand is excellent.

27. VERDANT GREEN.—Large hand is too large, and the small hand too much spread out. Down strokes of the small hand especially should be more even in thickness.

28. ROGO.—Small hand is written with side of pen. Hence lower curve is thicker than the downstroke, and the upper curves are pointed. The regularity and general style are good, as is also the large hand. Tracing not allowed; percentage 80. The use of the word is a matter of taste; we think the use of it is customary and justifiable.

29. MOT KCIWDAHC.—(1) Your query was solved in our issue for March, 1882. (2) Your specimen writing is *pretty fair*.

30. ALICE.—You will obtain the correct signs by the following methods :—

$$\begin{aligned}
(1)\ (a+b-c)^2 &= \{(a+b)-c\}^2 \\
&= (a+b)^2 - 2(a+b)c + c^2 \\
&= a^2 + 2ab + b^2 - 2ac - 2bc + c^2 \\
&= a^2 + b^2 + c^2 + 2ab - 2ac - 2bc.
\end{aligned}$$

$$\begin{aligned}
(2)\ (a-b+c)^2 &= \{(a-b)+c\}^2 \\
&= (a-b)^2 + 2(a-b)c + c^2 \\
&= a^2 - 2ab + b^2 + 2ac - 2bc + \\
&= a^2 + b^2 + c^2 - 2ab + 2ac - 2
\end{aligned}$$

$$\begin{aligned}
(3)\ (a-b-c)^2 &= \{(a-b)-c\}^2 \\
&= (a-b)^2 - 2(a-b)c + c^2 \\
&= a^2 - 2ab + b^2 - 2ac + 2bc + c^2 \\
&= a^2 + b^2 + c^2 - 2ab - 2ac + 2bc.
\end{aligned}$$

Or,

$$\begin{aligned}
(1)\ (a+b-c)^2 &= a^2 + b^2 + c^2 + 2(a \times b) \\
&\quad + 2(a \times -c) + 2(b \\
&= a^2 + b^2 + c^2 + 2ab - 2ac - 2bc.
\end{aligned}$$

$$\begin{aligned}
(2)\ (a-b+c)^2 &= a^2 + b^2 + c^2 + 2(a \times -b) \\
&\quad + 2(a \times c) + 2(-b \times c) \\
&= a^2 + b^2 + c^2 - 2ab + 2ac - 2bc.
\end{aligned}$$

$$\begin{aligned}
(3)\ (a-b-c)^2 &= a^2 + b^2 + c^2 + 2(a \times -b) + 2(a \times -c) \\
&\quad + 2(-b \times -c) \\
&= a^2 + b^2 + c^2 - 2ab - 2ac + 2bc.
\end{aligned}$$

31. DENNY, Leamington.—*Hamblin Smith* has not published a Key to his 'Exercises on Algebra.'

32. H. J. W.—The equations to 3 circles are :—

(α) $y^2 + x^2 = 3$,
(β) $x^2 + y^2 - 6x - 10y + 25 = 0$,
(γ) $x^2 + y^2 - 4(4x + y) + 52 = 0$.

Show that the line joining centres of (α) and (β) is perpendicular to that joining (β) and (γ). (*L. C. P. Exam.*, 1882.)

(α) $y^2 + x^2 = 3$;
$\therefore$ Co-ordinates of centre are 0, 0.

(β) $x^2 + y^2 - 6x - 10y + 25 = 0$
$x^2 - 6x + y^2 - 10y + 25 = 0$
$(x^2 - 6x + 9) + (y^2 - 10y + 25) = 9$
$(x-3)^2 + (y-5)^2 = 9$;
$\therefore$ Co-ordinates of centre are 3, 5.

(γ) $x^2 + y^2 - 4(4x + y) + 52 = 0$
$x^2 + y^2 - 16x - 4y + 52 = 0$
$x^2 - 16x + y^2 - 4y = -52$
$(x^2 - 16x + 64) + (y^2 - 4y + 4)$
$= -52 + 64 + 4$
$= 16$
$(x-8)^2 + (y-2)^2 = 16$;
$\therefore$ Co-ordinates of centre are 8, 2.

Equation to the line joining two points :—
$(x_2 - x_1)(y - y_1) = (y_2 - y_1)(x - x_1)$
$\therefore$ Equation to the line joining the centres of (α) and (β) is :—
$(3-0)(y-0) = (5-0)(x-0)$
$3y = 5x$
$\therefore\ y = \frac{5}{3}x.$

$\therefore$ Equation to the line joining the centres of (β) and (γ) is :—
$(8-3)(y-5) = (2-5)(x-3)$
$5(y-5) = -3(x-3)$
$5y - 25 = -3x + 9$
$5y = -3x + 9 + 25$
$= -3x + 34$
$\therefore\ y = -\frac{3}{5}x + \frac{34}{5}.$

The line $y = \frac{5}{3}x$ is perpendicular to the line $y = -\frac{3}{5}x + \frac{34}{5}$.

Note.—Sparkes' work on 'Conic Sections' is the simplest (Stewart and Co.), but *Todhunter's* is the best.

33. SAUVAGE.—A tube, 1000 feet long, is filled with oxygen gas. Find how quickly the sound of a pistol shot will travel from one end of the tube to the other, it being given that the density of oxygen is 16 times as great as that of hydrogen, and that the velocity of sound in hydrogen is 4200 feet per second. (*Science and Art Examination.*)

Velocities of sound in gases are to each other inversely as the square roots of their densities.

$\therefore$ Velocity of sound in oxygen $= \frac{4200}{4}$ ft. per sec.
$= 1050$,, ,, ;
$\therefore$ Time for sound of pistol shot to pass down the tube $= \frac{1000}{1050}$ sec.
$= \frac{20}{21}$ sec. Ans.

34. B. PARTINGTON and SIGMA.—We cannot obtain the solution by the hints which are given.

35. REGINA.—*McLeod's* Series, first six books. Writing is legible, letters irregular and badly formed; as a whole the writing lacks neatness and finish. 60 per cent.

36. FIDUS ACHATES.—Peculiarities of 'Richard II.' are archaic forms of language, words now obsolete, differences of structure, infinitives for preposition and gerund, use of verbs as both transitive and intransitive, where they are now only one or the other, elliptical expressions, omissions of the nominative-relative, and many anachronisms.

37. PETIT MAÎTRE.—It would take a page; a few interesting facts respecting his life and works can be found in 'Men of the Time,' page 734.

38. S. B. V.—There is no small book on Mental Science we can recommend for your purpose. The papers in the PRACTICAL TEACHER are to the point. Prof. Sully's new work 'Outlines of Psychology' will be the standard work on the subject for years to come. Read 'Lectures on Teaching' by J. G. Fitch, Esq.

Mensuration.

1. P. T.—A cubic foot of gold is hammered out so as to cover an area of 6 acres; find the thickness of the gold in decimals of an inch, correct to the first two significant figures. (*Cassell's* 'Saturday Journal.')

$$6 \text{ acres} = (6 \times 4840 \times 9) \text{ sq. ft.}$$
$$= 261{,}360 \text{ sq. ft.}$$
$$\therefore 261{,}360 \text{ sq. ft.} \times \text{Thickness} = 1 \text{ cub. ft.}$$
$$\text{Thickness} = \frac{1}{261360} \text{ ft.}$$
$$= \frac{1}{21780} \text{ in.}$$
$$= \underline{\text{'000045...in.}} \quad \text{Ans.}$$

Note.—*Cassell's* 'Guide to Civil Service' (Cassell's), price 2s. 6d.; *Johnston's* 'Civil Service Guide' (Longmans'), price 3s. 6d.

2. CARN BREA.—The length and breadth of a rectangular room are measured with a defective foot-rule; the area appears to be 420¼ sq. ft., but is really 400 sq. ft. Find the error in the rule. (*P. T. Course.*)

$$\left(\frac{1 \text{ ft.}}{\text{Length of rule in ft.}} \times \text{Length of room in ft.}\right) \times \left(\frac{1 \text{ ft.}}{\text{Length of rule in ft.}} \times \text{Breadth of room in ft.}\right) = 420\tfrac{1}{4} \text{ sq. ft.}$$
$$\therefore \left(\frac{1 \text{ ft.}}{\text{Length of rule in ft.}}\right)^2 \times (\text{Length of room in ft.} \times \text{Breadth of room in ft.}) = 420\tfrac{1}{4} \text{ sq. ft.}$$

(But, Length of room in ft. × Breadth of room in ft. = 400 sq. ft.)

$$\therefore \left(\frac{1 \text{ ft.}}{\text{Length of rule in ft.}}\right)^2 \times 400 \text{ sq. ft.} = 420\tfrac{1}{4} \text{ sq. ft.}$$
$$\left(\frac{1 \text{ ft.}}{\text{Length of rule in ft.}}\right)^2 = 420\tfrac{1}{4} \text{ sq. ft.} \div 400 \text{ sq. ft.}$$
$$= \tfrac{1681}{1600},$$
$$\frac{1 \text{ ft.}}{\text{Length of rule in ft.}} = \tfrac{41}{40},$$
$$\therefore \text{Length of rule} = \underline{\tfrac{40}{41} \text{ ft.}}$$
$$\therefore \text{Error in rule} = \underline{\tfrac{1}{41} \text{ ft.}} \quad \text{Ans.}$$

3. F. HOLTON.—A square foot of paper weighed 104·68 grs., and when 320 figures had been written on it, it weighed 105·155 grs. If a strip of this paper 5⅔ inches wide be taken to have written upon it the circulating period of $\frac{1}{100102}$ which consists of 100102 figures, in two lines at rate of 5 figures to an inch, find the weight of whole.

$$\text{Area of strip} = \left(\frac{\overset{50051}{\not100\not102}}{5} \times \frac{1}{2} \times \frac{23}{4}\right) \text{sq. in.}$$
$$= \tfrac{1151173}{80} \text{ sq. in.;}$$
$$\therefore \text{Weight of whole} = \left[\left(\frac{\overset{26{\cdot}17}{\not104{\cdot}68}}{1} \times \tfrac{1151173}{80} \times \frac{1}{\not100}\right) + \{(105{\cdot}155 - 104{\cdot}68) \times \tfrac{100102}{320}\}\right] \text{grs.}$$
$$= \left(\frac{30126197{\cdot}41}{720} + \frac{{\cdot}095 \times 50051}{\not100}\right) \text{grs.}$$
$$= (41{,}841{\cdot}9408472 + 148{\cdot}58890625) \text{ grs.}$$
$$= \underline{41{,}990{\cdot}529753472 \text{ grs.}} \quad \text{Ans.}$$

*** *Many Queries are unavoidably held over.*

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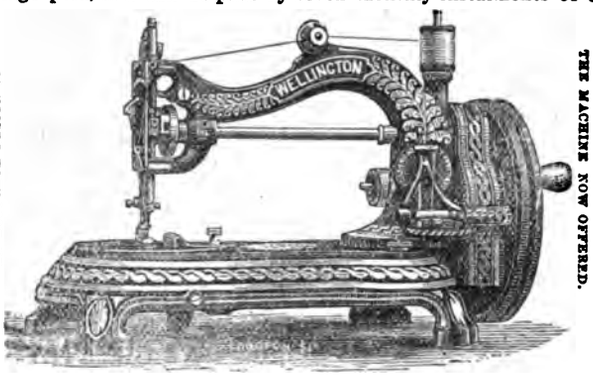

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WATER—(*Continued*).

THE effects of an impure supply of water are now too well known to be insisted upon here. They differ according as to whether the water is contaminated with sewage products and other animal refuse, with organic materials, such as decomposing vegetable matter, or with inorganic substances. Sewage in potable water, sooner or later, will produce certain effects, such as irritable mucous membrane, lassitude, diarrhœa, and anæmia, ending at length in continued or enteric fever, or cholera. Other organic impurities produce dyspepsia, loss of appetite, erysipelas, and dysentery. In hot climates yellow fever and other zymotic diseases are caused by the use of polluted water, different kinds of entozoa have been spread by it, and parasitic diseases set up in both men and animals. The Elephantiasis of the East has been ascribed to its use. The continued use of a water which contains excess of saline constituents will also produce different kinds of mischief. Diseases of the skin have been ascribed to the continued use of mineral waters, and similar states in the mucous membrane of the bowels may arise. Goitre appears to be due to the use of water from the magnesian limestone formation. This has been denied by some, though the evidence in the negative is not satisfactory. Sulphate of lime will also produce dyspepsia and other disorders when it is in excess, and disease of the bones have been set up, especially if SO_3 happens to be present. The use of water which is too pure is also said sometimes to have promoted the production of rickets. This has been ascribed as one of the results of the use of the Loch Katrine water in Glasgow; but it is denied by some who speak with authority, as not being sufficient to account for the presence of that disease in the northern metropolis of commerce.

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(7) The Iodo-bromated waters.

(1) *Carbonic acid waters.* This class is not, as generally understood, a natural class: there are a few springs which contain small quantities of saline ingredients with excess of CO_2, but they are evanescent. These waters are manufactured articles, and constitute the ordinary soda or potass, and other bottled waters, which now so properly appear on the dinner-table, in addition to or in place of alcohol. It is said that the excess of CO_2 chemically assists the solution of the bicarbonates, lessens gastric irritability, acts upon the secretions of the stomach and kidneys, and thus promotes the removal of *débris* from the body.

(2) *Saline waters* are subdivided into (*a*) *simple alkaline waters*, which contain carbonate of soda (Na_2CO_3) as its principal mineral constituent. Vichy is the most noted representative. Vals, Bilin, Apollinaris, Salzbrunn, Mont Doré are in the same class. (*b*) *Chloride of sodium waters*, in which common salt is dissolved with the alkalies: it includes Ems and La Bourboule. (*c*) *Bitter waters*, which contain more or less of the sulphates of soda and magnesia, such as Friedrichshall, Hunyadi-Janos, Pullna, Seidlitz, and (at home) Epsom, Beulah Spa, Streatham, Purton Spa, Cheltenham, Leamington, and Scarborough. (*d*) *Compound soda waters:* in this division we have Carlsbad, Marienbad, Franzensbad, and some less known. (*e*) *Simple salt waters*, of which Homburg and Kissingen are the most noted. There are also Wiesbaden, Baden-Baden, Kreuznach, and also Droitwich in this country.

(3) *Sulphur waters.* These waters contain sulphuretted hydrogen, in alliance with different salines; most of

them are natural baths in high ground, with doubtful climates. Those in the Pyrenees are most noted, but Aix-les-Bains, Aix-la-Chapelle, and the British sulphur springs of Harrogate, Moffat, and Llandindod are important. These waters are sometimes chalybeate as well as antacid and diuretic.

(4) *Earthy mineral waters* are found at Weissenburg, Leukerbad, Wildungen, and Insebad. They have excess of lime and magnesia, with silica and iron.

(5) *Indifferent waters* are those without active chemical ingredients, such as Buxton, which is a warm water, with great quantities of nitrogen and very little saline. Bath is somewhat similar, but warmer, with more solid constituents. The position of Buxton differs, however, from Bath in its elevation above the sea-level, being 900 feet; abroad there are Teplitz, Plombières, Ragatz, Gastein, and Wildbad.

(6) *Chalybeate waters* obtain their notoriety from the quantity of ferrous carbonate in solution. Exposure to the air allows the escape of the CO_2 which held the iron in combination, oxygen is absorbed, and the iron falls as an hydrated ferric oxide.

Many of the preceding springs are also chalybeate, such as, among alkaline waters, are Ems, Salzbrunn, Bilin, Apollinaris. Alkaline salines have Marienbad, Franzensbad. Those more decidedly saline include among the chalybeate list, Kissingen, Wiesbaden, Baden-Baden, and Kreuznach; almost all the principal watering-places have chalybeate spas, but those most in use are Spa (in Belgium), Pyrmont, Schwalbach; and in our own country, Tunbridge Wells, and Harrogate; whilst at Brighton, Malvern, Bournemouth, and Sandown springs are found slightly impregnated with iron.

(7) *Iodo-bromated waters* are a small class containing iodine and bromine in minute quantities. They are found at Kreuznach, Woodhall Spa, and Purton Spa, a small village in North Wiltshire which promises to be a valuable addition to this class of Spas in this country.

It is the custom for certain classes of invalids to go to health resorts, both at home and abroad, for the purpose of 'drinking the waters,' and clearing their constitution from maladies which are the result of various causes, such as luxury and indolence, or of over mental and cardiac strain, the wear and tear of business, or active professional life, or merely because it is a fashionable thing to do.

Much of the benefit which results from this custom arises from the complete change of habit which the patient undergoes, for the responsible advisers at those resorts take care to insist upon early rising in the morning, so as to diminish the relaxing effect of too much sleep, and to strictly inculcate temperance in eating and drinking, as well as the free use of the diluent. The major portion of the waters act as resolvents, scouring the mucous membrane of the bowels, and sometimes acting freely on the kidneys, and thus are blood purifiers to a large extent, whilst in some cases active exercise is also insisted on by local physicians, by which the skin is made to freely perspire, and the capillary vessels become unloaded, as well as the vascular system of the mucous surface in the bowels.

The most aperient class are Hunyadi-Janos, Friedrichshall, Carlsbad, Pullna, Kreuznach, Kissingen, and Ems, whilst Apollinaris, Seltzer, and Vichy are used for dietetic purposes to a very large extent. To these must also be added, potass, soda, and lithia waters, which are now generally at hand in all well-regulated establishments, for the purpose of diluting wines, and diminishing the incidence of free living. In these waters the alkali is held in combination with an excess of CO_2 under pressure. The excessive use of aerated waters is not to be commended in every kind of constitution, and at all seasons, but when a man suddenly gives up his beer and takes to water, because he is no longer able to digest beer with comfort, or for any other reason, it is wise to take a sufficient quantity of liquid to replace that which the individual was accustomed to take, otherwise the so-called abstainer will find himself, after a time, not so well as he might be for his change of habit.

It is now established that alkalies increase the secretion of gastric juice, and so assist digestion, but when used for this purpose they should be taken before a meal, but if there is acid eructation, and a state of flatulency after food, the use of small doses of alkali in the form of a mineral water is very beneficial. The most perfect type of a mineral water is that produced by Packham and Co., of Katharine Street, Croydon, whose manufactory is the perfection of order and cleanliness. The various waters are made up with distilled water, to which a fixed quantity of the various salts which constitute the natural waters, are carefully added so as to imitate the natural water as closely as possible, except in one point—they are completely freed from the organic matter which too often pollutes the natural springs. The quality is always the same, and in practice I much prefer to order waters manufactured at that establishment, and so obviate the risk of giving my patient an attack of typhoid fever or diarrhœa, by advising them to drink some of the abominations which are said to be bottled at the springs. Healthy men and women do not require mineral waters, but they are very useful in chronic functional disorders, in debility, whether the sequence of some general disease, or in the early stages of organic disease, and in all cases in which the appetites of men have taxed their digestive organs beyond their natural power; but we must bear in mind that a too long continuance of salines, especially in cold weather, is liable to upset the digestive organs, as well as put them right. Packham's Hedozone, a phosphated iron tonic, is superior to any of the natural chalybeate waters, and without asserting that our local manufacture is far superior to any other for the manufacture of artificial aerated waters, I am quite satisfied from personal knowledge of the purity of the articles bottled there, and I fully endorse the observations made by the *London Medical Record* and the *Lancet* as to the safety with which they may be moderately used by those who labour under any kind of weakness of the digestive organs.

ALCOHOLIC BEVERAGES.

These are now so often diluted by mineral waters that we may refer to them here.

Alcohol is a powerful medicine taken in a full dose in any form. It dilates the capillaries, causing a passive congestion, delaying the progress of the blood from the periphery of the body back to the heart, and thus for a short time relieves that organ of its work; but by delaying circulation, it prevents the removal of used-up matters, and retains *débris* within the current

of the blood, or within the cells which ought to be engaged in the active duty of removing the waste. Alcohol delays tissue-change, and may therefore be used when oxidation is in excess of the requirements of the body, or when food is not forthcoming to supply waste, but it is not in itself a food, and cannot be so considered. Its use, under certain circumstances, may, as it were, assist a lame dog over a stile, but by continual use the lameness will never depart, and the stiles will be more and more numerous, for it prevents the very action which is necessary to remove the cause of the lameness out of the system—viz., unoxidised *débris*. It is possible that a diet drink of pure malt and hops may have a small amount of food in the extraction and salts which it contains, but pure malt and hops are not now attainable, and since the Legislature has allowed the use of molasses in the manufacture of the national drink, its comparatively harmless nature has departed, and as with the introduction of molasses, the use of various bitter extracts besides that of hops becomes common, and the source of which extracts the chemist cannot detect, the use of beer is likely, in the course of time, to go out of fashion. Even the working man is finding out its noxious quality. I was conversing upon this point with an extensive brewer the other day, and he told me that he believed the soil of the hop-growing districts in this country was becoming exhausted, and that brewers could not get the same results from a pocket of Kent hops as they used to do, and as a consequence they were obliged to use other vegetable bitters. Be that as it may, from personal experience I believe the use of molasses will eventually destroy the national beverage, as, since that change has been made, with me it undoubtedly promoted the rheumatic diathesis, and I was obliged to give up its use. Natural wines, manufactured from the simple juice of the grape, and without fortification or the addition of a 'bouquet,' may be comparatively harmless in moderate quantities, and even beneficial under certain circumstances; but it is a difficulty to get such. The haste to be rich by making large profits leads to sophistication and adulteration, and as a consequence the human race suffers. As a rule, I prefer to drink water. If I can get it pure, so much the better, and if it is not pure I prefer to have it boiled and used as tea or coffee, or with some such addition as toasted bread, to the use of the abominations which are put into bottles, which have various deadly poisons drawn from the amylic-æther series of compounds added to them for the purpose of giving 'bouquet' to the odour, and making believe that they are something *recherché*, when they are only mixtures of several spoilt vintages and chemical manufactures after all; and their æsthetic properties are less than moonshine, for they make things appear to be what they are not, and alter things that are for the worse and not the better.

(To be continued.)

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THE Conference on Education to be held at the Health Exhibition promises to be one of unusual importance. Papers will be read on various topics relating to school work. A glance at the list lately published shows that many of the best-known educationists in this country have given their support. Representatives from Belgium, France, Germany, and Switzerland are also expected. Teachers who intend to spend their holiday in London will have a rich treat in store.

The New Class-Subject, 'Elementary Science.'

(What to teach, and how to teach it.)

BY RICHARD BALCHIN.

IN last month's issue of this magazine will be found a sketch of the course of easy lessons in zoology which, it appears to me, may well be included in the 'Elementary Science' for Standard IV. I also gave the outlines of Lesson I., on the distinction between vertebrata and invertebrata; and of Lesson II., on the classification of the former sub-kingdom into the five classes—mammals, birds, reptiles, amphibians, and fishes. I now propose to take the lessons in each of these classes, beginning with the lowest—viz., fishes. Leaving out of consideration the skeleton, we shall describe the main characters of the members of the various groups under these four heads:—(1) Circulation; (2) Respiration; (3) Skin-covering, etc.; (4) Manner of Birth.

LESSON III.

FISHES (Circulation and Respiration).

Place before the class the school-picture (Murby's set) of the organs of a fish. Carry on a conversation about the picture, and point out the heart, gills, and air-bladder, scales, fins, and roe. Then cut open a fresh-herring, and show the organs represented in the picture.

(1) Circulation.—Note the small heart just under and in rear of the gills. Heart has *two* chambers, one auricle and one ventricle. Our heart has *four*. Impure venous blood from all parts of the body of the fish enters the one auricle, passes to the ventricle, goes to the gills, where it is changed into pure arterial blood, which then passes to a large artery called the aorta, from which it is distributed over the body of the animal.

(2) Respiration — Breathing.—*We* breathe air. Fishes also breathe air. But *we* breathe the air as it is. Fishes breathe air dissolved in water. Air is soluble in water. Experiment:—Half fill a Florence flask with water. Shake it up: some of the air dissolves in the water. Heat the water—not to the point of boiling—over spirit-lamp: note the minute bubbles of dissolved air being driven out of the water by the heat. Air is a mixture of nitrogen and oxygen. Boys have learnt this already. The nitrogen and oxygen do not dissolve in water in the same proportion as they exist in the air. More oxygen dissolves than nitrogen—*i.e.*, oxygen more soluble in water than nitrogen. (This, by the way, is a striking proof that the air is a mechanical mixture of gases, and not a chemical compound.) Fishes breathe this oxygen which is dissolved in the water in which they live. Water is gulped by the fish. This water passes over the gills. The blood in the gills absorbs the oxygen which is dissolved in the water. (Note:—The boys know that water is H_2O, and they will think that the fish obtains its supply of O by the decomposition of water. Guard against such error.) *We* use up the oxygen of our air, and return carbon dioxide (CO_2). Fishes also use up the oxygen dissolved in water, and return to the water CO_2. (Note:—CO_2 very soluble in water: instance soda-water.) Aerial plants remove the CO_2 which *we* exhale, and aquatic plants in like

manner absorb the CO_2 which fish exhale. Hence water of fish-globes, or aquaria, must either be often changed or aquatic plants, *e.g.*, watercresses, must be allowed to grow in the aquarium. Explain the position and probable use of the air-bladder.

LESSON IV.

FISHES (Skin-covering, etc., and Manner of Birth).

Have the picture as before, and two fresh-herrings, a hard roe and a soft roe. Recapitulate a few facts respecting circulation and respiration, and then proceed to notice :—

(1) Skin-covering and Fins.—No hair on a fish. Scrape off a few scales. Show that if a scale were *fringed* on its edge, and the horny part contracted to a middle ridge down the scale, we should have something not unlike a little feather. This for future reference when we come to speak of the feathers of birds. Note the two pairs of fins, the pectorals and the ventrals; these answer to the four limbs of other vertebrates.

(2) Manner of Birth.—Hard-roed herring, the female. Soft-roed, the male. Hard roe, a collection of what will become eggs. Not eggs while in the body of the fish. (Note :—Some people will not eat a hard roe for fear the ovules should turn to fish in their digestive organs. A mistaken notion.) Compare the ovules in the ovary of a flower. Boys have already learnt this in previous lessons. These ovules become seeds when the pollen from the anthers has fertilized them. Explain that the hard-roed herring deposits some of its roe upon a water-plant or a stone in the water. Soft-roed herring comes and deposits upon this hard roe some of its soft roe. Then the ovules become eggs, from which little fishes are hatched. I find that boys who have kept 'stickle-backs' have really noticed all this.

(3) Note that the lowest fish—the lancelet—can scarcely be said to have a backbone at all, nor a heart; so closely are fishes connected with the sub-kingdom invertebrata. While the highest organized fish—the mud-fish—has not only gills, but also lungs for breathing the air as *we* do; and is thus closely connected with the next class of animals above them—viz., amphibians.

LESSON V.—AMPHIBIANS.

Frogs, toads, newts, salamanders, etc. Show picture of the organs of a frog, and have before the class the school aquarium, if there be one. Carry on a conversation about a frog, and get from the boys all they know about this animal. Then proceed to note :—

(1) Circulation.—(*a*) As a tadpole its circulation is the same as that of a fish. Recapitulate what this is. (*b*) As a fully-grown frog, the heart has three chambers : two auricles and one ventricle. Impure venous blood from the body enters the right auricle, passes to the ventricle, thence to the lungs, absorbs the oxygen of the air, and is changed into arterial blood, which returns to the ventricle; in this chamber there is consequently a mixture of venous and arterial blood. This half-oxygenised blood is then distributed over the system. Hence a frog's body feels so cold. Amphibians, like fish, are cold-blooded animals—*i.e.*, the blood is colder than the surrounding medium; ours is warmer.

(2) Respiration.—(*a*) In the tadpole state, the respiration is by gills, the same as a fish. (*b*) As a fully-grown frog, it is by lungs, as is the case with us. Here explain the word 'amphibian,' 'both lives'—that of fish and that of reptile. Note :—Dispel the common error in defining an amphibian, as 'an animal that can live in the water and on the land.' It will be soon apparent that the boys consider such an animal as the 'seal' an amphibian.

(3) Skin-covering, none. Limbs four, formed for swimming.

(4) Mode of Birth.—From eggs or spawn deposited in the water, generally upon aquatic plants; nearly the same as in the case of fish. This is given with sufficient fulness in the Science Reader.

LESSON VI.—REPTILES.

These are—(1) crocodiles and lizards; (2) snakes; (3) tortoises and turtles; of which the highest in the scale are crocodiles, and the lowest, tortoises and turtles.

(1) Circulation.—Like that of a frog; but at no period of its life does a reptile possess a heart of two chambers; always of three or four. There are two auricles and one ventricle, through which the circulation is the same as that of a frog, and the blood is cold. But in the case of tortoises, turtles, snakes, and lizards, there is a sort of beginning of a division of the one ventricle into two parts by the growth of an incomplete septum; this septum is, in the case of crocodiles, quite perfect; and here we have a heart of four completely distinct and separate cavities. This is extremely interesting, and the boys will easily grasp the fact by the aid of a few rough sketches on the blackboard.

(2) Respiration.—Never by gills; always by lungs. Hence a reptile cannot, in breathing, obtain its necessary supply of oxygen from the air dissolved in water, but always *directly* from the atmosphere, as we do.

(3) Skin-covering.—Thick scales, as in the case of turtles, etc., or strong horny plates, as in tortoises. Never feathers, nor hair.

(4) Mode of Birth.—The young is hatched from an egg. About April or May the female crocodile lays about twenty eggs, generally in the warm sand by the side of a river. She is a careless mother, and scarcely covers up the eggs. The little ones are hatched quite alone, and are five or six inches long. After a few days the mother finds them, and leads them to the mud on the river bank, and feeds them. The father takes not the slightest notice of them.

(To be continued.)

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Article 106 (*b*).

Merit Grant in Infant Schools.

BY MRS. MORTIMER,

Lecturer on Kinder-garten at the Home and Colonial Training College, London.

Section II.—Phenomena of Nature.

LESSON—FROST.

WHEN we talked about the rain the other day, you said you liked it to come sometimes. Will you tell me when it is that you like the rain? That is quite right, when it

has been hot we like the rain to fall. Why? Because it makes the air cool. When do we have very hot weather? In the summer. Then it is in the summer that you like the rain. Which part of the year do we have most rain? Yes, we have very much more rain in the winter than in the summer. What kind of weather do we have in the winter? Cold weather. One winter's day it had been raining very much; the gutters were full of water, and a tub and some pails in the garden also had water in them. All that night the wind blew, and it was very cold. In the morning when I went out I felt very cold; the pavements were dry, and instead of water in the gutter, I saw something that I could stand on. It looked very bright, and was very smooth. Do you know the name of it? Yes, it is called 'ice.' How did the ice get there? Well, listen. You know there was water in the gutter, and that the weather was very cold. Well, this cold weather turned the water into ice. I went into the garden afterwards, and found ice covering the top of the tub and pails, and I found the water in the water-jug frozen. What do we mean by frozen? We mean the water has ice on it. Now, if I wanted to get some water out of the tub, what should I have to do? You would have to break the ice. What should I find? The water under the ice. What can you tell me then about the ice? It is at the top of the water. Yes, the water only freezes at the top. Sometimes the ice is very thin, and sometimes it is very thick. Can you tell me why this is so? It is thick when the weather is very cold. Yes, and if the weather keeps cold, the ice gets thicker, and it is then very hard and strong.

Where is the water kept that we use in the house? In the cistern. How does it get into the cistern? Through little pipes from the street. Can you see the pipes in the street? No, they are under the ground. Yes, they are very large, and being in the ground the water does not freeze. The water in the small pipes, however, often freezes; and then what happens? The cistern is empty. What do you have to do then? Mary says her mother asks the lady next door. Perhaps the lady next door is without water, and then what do we have to do? We must look out for the man who puts a pipe up in the street. Yes, the turncock puts a pipe in the street, and then the water comes up out of the big pipes under the road. What do you do then? Our mother or big brothers and sisters take the pails, and cans and jugs, and get them all full of water. What does your mother do? She sees that everything is full of water; and she will not let us play with it. No, we must all be very careful indeed when the frost is hard. Do we use much water? Tell me some of the things for which we want water. We want water for washing ourselves, our rooms, our clothes, and things we use; for cooking some of our food, for drinking, etc. Yes, you see then it is very awkward to be short of water. Does it always rain before it freezes? No, sometimes it is quite dry. How can we tell it is freezing? By the cold weather. And any other way? The ground gets very hard, and if there is any water about, it gets covered with ice.

I daresay some of you have seen the water in the parks. What do we call this water? Ponds and lakes. Well, sometimes when it is very cold these lakes and ponds are frozen over with thick ice. Do you know what some people do then? Yes, they go on the ice, and slide and skate. They like this very much indeed, and it keeps them very warm. The teacher might here point out the difference between sliding and skating, and should it be convenient, a pair of skates should be shown to the children.

Do little children go out when it is freezing? Yes. What do their mothers do to them? Wrap them up in very warm clothes, and tell them to run about. Why must they run about? To keep themselves warm. Sometimes I see little children crying, but that is because they walk or stand about instead of moving about quickly. Do you know any good games for cold weather? Tell me the names of them. The teacher should here caution the children about the danger of making slides on the paths, etc. Have you ever seen cabmen and other men that drive horses beating their arms in the winter? Show me how they do this. Why do they do it? Because they are cold. Yes, they have to sit still and drive, and, therefore, they get very cold unless they move their arms about.

Sometimes the frost looks very pretty, especially in the country, on the grass and trees. The frost covers the branches with white, something like snow, but there is only a little of it, and it is very fine. When the sun shines the branches seem to sparkle, and look very pretty. It looks just as if the trees were covered with powdered glass. You might think it was fine white sugar.

One morning after the frost had lasted a long time, the weather became warmer, and your mother turned on the tap, and found little drops of water coming out. After a time these drops came quicker and quicker, and at last the water began to run out again like it did before the frost came. Then she went into the garden, and found the ground was softer. Can you tell me what made the water run again and the ground get softer? Yes, the warm weather. Yes, we say it is the *thaw*, and we always have this after a frost. When does the frost go away? When the rain comes, or when the weather gets warmer. Does the frost always come in the winter-time? Do you know what we call the time when the flowers begin to come on the fruit trees? Yes, the spring. Sometimes the trees are all full of bloom, and the farmers think they will have a fine fruit season, but the frost comes back, and then what do you think happens? It freezes the blossom. Well, we do not say the blossoms are frozen; we say the frost kills the blossom, and that means the blossom will not turn into fruit.

Section III.—Scenes of Common Life.

LESSON—MARKETS.

I. *Introduction.*—The teacher should question the children as follows:—Where do you buy meat? At the butcher's shop. Where do you buy potatoes, greens, apples, oranges, etc.? At the greengrocer's. Where do you buy fish? At the fishmonger's.

II. *The Markets.*—Now, can you tell me where the butcher gets all the meat he has to sell? From the market. And where the greengrocer gets his fruit and vegetables? And where the fishmonger gets his fish? Yes, that is right, they all get their things from the market. Do they all get their things from the same market? No; the butcher gets meat from the meat market, and the fishmonger gets fish from the fish market, and the greengrocer gets fruit and vegetables from another market. Can you tell me what a market is? Well, it is a very large place with a great many shops in it; the shops are quite close together, and in the meat market every shopkeeper sells meat; in the fish market every shopkeeper sells fish. Why do the shopkeepers go to the market to buy the things they sell? Because they can buy enough to fill their shops—as much as they want. Could the butcher go to a shop and buy so much meat? Then he can get the meat very much cheaper at the market—if he were to buy it at a shop, he would have to pay just the same money for it as he would have to sell it for. That would not do at all. Why not? Because he would have all the trouble of fetching the meat and selling it, and would gain no money.

Do any other people buy at markets besides those who keep shops? Yes, any one can go into a market and buy. When do the shopkeepers go to buy? Early in the morning, then they have their things ready in their shops for people who wish to buy of them: but other people can buy in the daytime in the market. Why does not everybody buy at the market? Because it is too far off. Is it 'too far' from everybody? No; some people live near the market, and they generally buy at the market. Why? Because they get their things cheaper.

Now, you have told me that shopkeepers get their things from markets, I wonder if any one knows from

where the people in the markets get them. Well, I will tell you. Do you know what the men who keep a great many sheep and cows and bullocks are called? No, they are not butchers. What do the butchers have done to these animals? They are killed for them to sell. The men who keep these animals until they are ready to be killed are called farmers. Do you know where these men live and look after their animals? In the country. Yes, they have very large fields where they grow grass, corn, and other food for the cattle. The farmers send the animals to the cattle markets, and the butchers buy them, and when killed they are sent to the meat market. Sometimes the animals are killed in the country, and then they are sent to the meat market, instead of the cattle market.

Now, can any one tell me from whence the fish comes? From the sea. How is it got from the sea? What are the men called who catch fish? They are called fishermen. These fishermen catch the fish, and send it to the market, and the fishmongers go there to buy it.

Perhaps some one can tell me where the fruit and vegetables come from. Yes, they also come from the country. If you go into the country you may see large fields of potatoes, other fields of cabbages, others of peas, others of strawberries, and other things sold by the greengrocer. Sometimes you may see some trees with apples on them, some with pears, and some with plums; under these trees you will see bushes with gooseberries, currants, etc., growing on them. What is the man called who looks after all these things? A gardener. What does the gardener do with his things when they are ready for use? He sends them to market. If the market is not too far away, the gardener packs his vegetables in very large waggons. I saw some very large waggons the other day packed quite full of cabbages, and not only in the waggon, but a long way up above. How do you think the men keep these from falling off? Yes, they were tied round very firmly with rope. The waggons were going along very slowly because they were very heavy loads for the horses. They start in the evening, and go on walking all night, then they get to the market very early in the morning, ready for the shopkeepers who come to buy.

III. *Principal Markets of London.*—Now I should like you to tell me the names of some of the markets in London. Yes, the meat market is one, but that has a name. Does any one know what it is? It is called Smithfield. Has any one been to Smithfield? What do you see there? That is right. Meat, fish, poultry, bacon, and cheese. What do you mean by poultry? We get all these things at Smithfield, but you must remember there are really three markets here—one for meat, one for fish, and the other for poultry, bacon, cheese, etc. I dare say some of you have seen a great many carts full of hay at Smithfield. This is called the hay market.

Can you tell me of another market? Yes; there is another fish market called Billingsgate, and another one called Columbia Market, but fruit and vegetables are sold in Columbia Market as well as fish.

Do you know the name of a fruit and vegetable market? Yes; there is one called Farringdon Market, and there is a very much nicer one called Covent Garden. Has any one been to Covent Garden Market? What did you see? Then there are some markets where potatoes only are sold. These are called potato markets. There is one at Spitalfields. Does any one know where the cattle market is?

Then there is Cumberland Market for hay and straw, and the Corn Market at Mark Lane.

The names of the markets should be written on the blackboard, and if the children have had lessons in elementary geography, the map of London shou'd be placed before them, and the position of the markets pointed out.

Section IV.—Common Employments.

LESSON—THE SHOEMAKER.

I. *Introduction.*—What covering do we have for our feet? Boots and stockings. Why do we wear these? To keep our feet warm. What is the use of stockings? To keep our feet and legs warm. Could we go into the streets with stockings only on? Why not? They are not thick enough to keep out the cold, and they would let the wet through, and if we were to tread on a stone it would hurt our feet. The boots do not let water through, and they are hard, so that if we tread on a stone it would not hurt us. Now we are going to talk about the boots to-day.

II. *Materials and Tools used.*—You see I have a boot for you to look at, and what is this? A shoe. Of what are they both made? The children should repeat 'Boots and shoes are made of leather.' What is the man called who makes boots and shoes? What must he have in order to do his work? He must have tools. I have some of the shoemaker's tools on my table, you shall tell me all you can about them. The teacher might then point to the different tools, and if the children do not know them, tell them their names, and write them on the blackboard.

Now, perhaps some of you could tell me how the shoemaker uses these tools. Who has ever seen a shoemaker at work? What was he doing? Well, John, you say you saw him hammering. What was he hammering? The heel on a boot. Was the heel ready-made, and the man hammered it on? No, he nailed one thin piece of leather on, than another piece on that, and then others until the heel was high enough. Who can show me the heel of this boot? Can you see the different layers of leather? Did you see, John, what the shoemaker had inside the boot while he was making the heel? What shape is the last? Can you tell me the use of it? Yes, the shoemaker always puts it inside the boot when he has to hammer nails in it. It would be very awkward to hammer the boot without something firm inside. Have you ever seen the man put a sole on a boot? That is done much in the say way as the heel is done, but there are not so many layers of leather as in the heel.

Mary says she saw a shoemaker sewing. Did you notice what he did to the thread before he used it? He rubbed something on it. Well, here is the something; what is it called? Why does he rub the wax on the thread? It makes it very much stronger. Have you ever seen any one else use wax? Yes, sometimes your mothers do, if they want their work to be very strong.

For what does the shoemaker use the pincers? Show them to me. Now show me the awl. What is the use of it? The man makes holes in the leather with the awl, and then he puts his needle through. Why does he not put the needle through at first? Because the leather is too hard.

What are these little things called? Pegs. Of what are they made? For what are they used? Instead of sewing the boots, men sometimes peg them; that is, they hammer the soles on with these little pegs. Which are the stronger, sewn or pegged boots? Yes, the sewn are the stronger, and we generally have to pay more money for them.

What is the use of the knife? To cut the leather. Have you ever seen the bootmaker use paste? What did he do with it?

Now, I must tell you that it is very seldom that one man makes a boot entirely himself. Generally, different parts are given to different people to make. Some parts are made by women. What do we call this part of the boot? The uppers are generally made by women, and they require other tools besides those we have mentioned, but those you must learn about another day. Some shoes are bound like this (showing a shoe); this is done by women, and the inside of the boot, the lining, is also done by women.

When the different parts of the boots are made, they are put together by men.

(To be continued.)

The Discipline of the Mind.

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IV.—The Processes of Reasoning.

A familiar contrast of common discourse is that of Thoughts and Things. The one term is usually taken as the summary of the contents of an individual consciousness excluded from the outer world; the other stands for a realm of existences equally secure from the invasion of spiritual forces. A very little consideration, however, shows the necessity of a revision of this time-honoured Dualism, the conventional distinctions failing, on closer inspection, to retain their sharpness of definition. 'Things' attentively regarded, appear tinged with Thought, and many so-called 'Thoughts' present themselves clad in material vestments. In other words the Real and the Ideal are found interfused, and a subtle analysis is required to yield the contrasted elements in their strict purity. A *Perception* is such a case of fusion, and a glib Dogmatism may easily be made to stammer on being challenged to assign the phenomenon its place in either of two mutually exclusive spheres. For, if the swift answer be, 'The Thought-realm, of course,' the compliance with the further request for a brief description of the other half of the Universe of Common Sense may be awaited with interest. Or should a less confident election be, 'The province of Things,' the pitiless Sphynx of Speculation who devours all easy-going Materialism will propound the puzzle, 'What is the matter of knowledge without the form of knowing?'

My purpose in these introductory remarks to the present section is not, however, to lead the reader into the hazy region of Metaphysics. My object was simply to induce a personal examination of those ever-recurring terms, *real* and *ideal*, in order to prepare the student for a full recognition of the *psychological* truth that the larger part of all apparent knowledge is charged with ideal elements; that what seems immediate apprehension is (say) one-tenth immediate, but nine-tenths mediate or indirect. Waiving the metaphysical question whether there be any non-mental reality, it is quite certain that the larger part of what we at any time characterise as *perceived object* is matter of inference from certain indications directly intuited. To an ordinary being possessed of eyesight the world of immediate apprehension is prevailingly a world of coloured visible forms, the objects directly discerned being enriched by attributes which frequent association has shown to be more or less regular accompaniments of these ocular phenomena. To the man smitten with blindness, on the contrary, tactile impressions overbear all others, as the world in which he moves and has his being; and memories of colour and visible form invest the nucleus of palpable fact, giving rise to an aggregate which is only differenced from that entering into the consciousness of the normal human being by the transposed vividness of the components. The ordinary man talks in terms of vision. He 'sees' and 'intuites' with the inward eye as with the outward; the blind 'feels' and 'grasps' his truth. But whether normal or abnormal, the portion added by imagination is by far the larger ingredient in all perception of objects; and a thorough training of the mind has to commence the logical discipline at this first stage of converse with the outer world.

The errors we commit in obtaining a real knowledge of the world are chiefly errors of classification, or of mistaken identification. Accurate knowledge of an object implies adequate distinction of parts, and faithful assimilation of actually observed with identical remembered qualities. So far as the primary sense-endowment and the sufficient exercise of the senses are concerned, this subject has already been considered; but a careful training of the Senses only carries us a little way towards the goal of real knowledge, or a just apprehension of the relation of sense-experiences. The disciplined senses having given in their report, imagination at once essays to fill out the picture, and the understanding proceeds to assign the object its place in the system of known things. As, however, sense may be confused, so imagination may exaggerate, and the judgment may be disordered. The imagination, of which we here speak, in the train of ideas representing former sensations which have been previously associated with the sensations now present. These associated ideas are dragged into the forecourt of consciousness in conformity with the 'Law of Contiguity,' and their procession is so swift and unbidden that they seem like a portion of the actual sensation, it even requiring an effort to convince ourselves that we do not actually see the solid block, or encounter the resistance of the impenetrable object. Equally prompt is the classifying function of the intellect. To speak, indeed, of this recognition of the object as something different from its mental construction verges almost on the tautologous. For in the very act of evoking sensations from the pit of memory we are pronouncing a tacit judgment that 'Here is an object possessed of marks presented by members of a certain class.' However, as this reference to a class is exceedingly important in the development of knowledge, it still seems desirable to consider this act of judgment as a distinct moment in the progress of perception.

As then we recognise two psychological processes subsequent to the original impression, a discipline of the mental powers will provide for the imperfect performance of these processes. In the first place, we should be able to separate the additions of imagination from the primary elements of sense. I believe I am correct in saying that this is a training of the powers almost entirely neglected in the education of the young. But it is difficult to conceive anything more important than the habit of distinguishing between what we directly observe and what we fancy we observe. Does it require so profound an acquaintance with psychology to make a child carefully distinguish the impressions he is receiving at any moment through eye or ear, and the qualities which his unreflective consciousness take to be equally revealed through the senses active at the moment, as (say) the distance, the hardness, and weight of a remote object?

There will be a further gain from this habit of analysis. It being once well understood that our perceptions are largely ideal, that is, are the joint product of actual sensations and remembered sensations, it will come to be admitted that the accretions of imagination may form so large a part of the whole, that the

classifying of the object may more depend upon them than on the actual intuition. In the next place, then, the mind must be accustomed to control its identifications, must not yield to the first suggestions of the presentation, but must be alive to the possibility of bias through the circumstances of the environment, or the condition of the faculties at the time.

In affirming an object to be this or that, I perform the simplest act of reasoning. The ground of my affirmation is the resemblance between certain properties believed to be present, and similar properties manifested on former occasions. In truth, my inference is freighted with a double chance of error. I believe that the imagined attributes are really there on the strength of certain felt sensations, and I believe that the object thus *perceived* is one of a class of objects which I have already formed by previous acts of comparison, that it is correctly *conceived*. A very slender thread of reality may bear a huge superstructure of belief. Of course the only final and sufficient test of the correctness of my inference is the elimination of the ideal elements by reducing the perception to sensation; but when such reduction is impossible (as in most cases it is), I must be content with guarding the process of inference by all the precautions logic is able to supply.

The perception is Sensation *plus* Idea, the conception is Idea pure and simple. Conceptions are the resembling constituents of a number of perceptions, which the mind has detached by a process called Abstraction, and which are made permanently available for comparison and inference, by being associated with certain conventional signs or names. It is in the operation on these symbols of idealised perceptions that reasoning in the narrower sense consists. But before we wholly leave the ground of reality it will be advisable to pay some attention to a mode of inference which plays a very large part in our daily life.

There is an unconscious kind of reasoning where we conclude from one special case to another on the bare superficial resemblance of the facts or circumstances. There is more than contiguous association, for it is the similarity that arrests the attention, but the inference is not extended beyond the particular instance, and the mind does not attempt to generalise its experience. It is not improbable that the brutes never get beyond this concrete reasoning, and certainly children and even adults of an unreflective turn of mind proceed largely upon these isolated identifications. But with the growth of the mind, observations are consciously generalised, and in place of concluding to a particular conjunction on the strength of another similar conjunction, the intellect infers to a class of indefinite extent, although the number of observed instances be but a fragment of the whole. This operation is called Induction, and its importance is at once seen when we consider how very few assertions of a universal character we should be entitled to make if we had to wait until we had examined every actual example.

There is a kindred mode of inference where the resemblance is one of depth rather than of breadth, and a conclusion is drawn on the strength of a certain number of common properties. We know (say) that two objects are alike up to a certain point, but are in the dark with regard to other agreements; one of the objects, however, possesses a further property. We then assume that the other object when better known will also be found to possess the same property. This kind of reasoning, which is known as Analogy, differs from Induction proper by the stress of the argument falling on the relative number of known and unknown properties in a very few objects; whereas in the latter case the inference is to the possession by a whole class of a particular attribute on the ground of its possession by a certain number of individuals.

Having arrived at a general truth by inferring that what is true of A and B and . . . . will be true of all objects that resemble A and B and . . . . in certain determinate characters, we may henceforth draw conclusions without further appeal to experience. Having affirmed possession of a property by class X (composed of objects known and unknown), we can predicate the possession of the same property by any object that falls within the description of the class. This is the species of reasoning termed Deduction, and though in this condensed statement the process may seem sufficiently evident, in reality its exercise often demands the highest tension of mind. It may be by a sudden perception of resemblance, a lightning flash of intellect defying all rule, that a grand principle is seized in a host of particulars, but the application of this principle will often tax the severest powers of thought. The axioms or fundamental principles of the sciences are soon reached, but the thorough-going application of such principles may constitute the main body of the science. Thus, take two sciences at the opposite ends of the scale, the science of simple quantity, and of economic values. The theorems of discrete quantity in the science of mathematics can be enunciated and proved by the mathematician confined to his room with (say) a pencil and a few sheets of paper. With a few conventional symbols and strenuous thought, long trains of reasoning may be carried on by him—the last link in the chain as certain as the first. Again, the laws of human industry, the theorems of commercial exchange, and principles of distribution of wealth may all be derived from a few familiar facts of human nature and a small number of fixed conditions of physical and mental life. And even the sciences which are most dependent on natural observation and experiment come with progress of time to be more largely deductive, and the development of rational conceptions will probably at some late stage of human history supersede induction by the aid of perception. As we see in Physics, not so long ago wholly experimental, entire branches are now cultivated mathematically or symbolically.

Science is but methodised common knowledge, and Reasoning is one and the same, whatever the sphere in which it is exercised. It is either good or bad, legitimate or illegitimate, according to the closeness of the resemblance of the attributes compared. The equivalence of geometrical figures is seen at a glance, and hence the inspection of a single diagram will supersede all further appeal to intuition, and we confidently universalise our theorem. Less exact will be our inference in the case of physical objects. A carefully performed experiment will compel conviction, but the question will always have to be raised anew: does the substance now before us perfectly resemble that on which we previously operated? When we come to the complexity of organic beings we are in more danger still of drawing inferences from superficial semblances—a trustworthy diagnosis often requires a very skilled physician.

Logic is the discipline of the rational power, and its importance in the higher education has always been recognised. Rather strangely, however, it has no place in the common school curriculum, an omission probably due to mistaken ideas as to its scope and nature. I can imagine only one ground on which this neglect might be attempted to be justified. It might be said that for the youthful mind the *matter* is more important than the *form* of knowledge, that the reasoning powers are best cultivated by working in the concrete, and that to abstract the process of reasoning itself, and make it an object of distinct consideration, would be as ill-advised as the teaching of grammar before practical familiarity with the forms of speech. There is truth in this, but it does not wholly hit the mark; for a logical discipline is practicable which is highly material, where examples drawn from the concrete are worked with, and the contact with reality is as close as in any study of mathematics or of polite literature.

For the teaching of logic in schools probably the usual order of treatment should be inverted, and an examination of fallacies form the first topic. A consideration of the methods actually employed in the branches of knowledge studied by the pupil would follow, and the doctrine of the syllogism might, perhaps, be profitably ignored. This may sound somewhat revolutionary, but the question of procedure is for the present of minor importance. When teachers in general come to undergo a logical training, prior to exercising their vocation, their estimate of the worth of the discipline may be expected to undergo great change. But, whatever the fate of logic may ultimately be, as regards general education, there can be no doubt about its importance for the teacher personally.

There is no lack of text-books on logic, but, considering the lavish expenditure of energy in this direction, it is astonishing how few writers succeed in giving a clear notion of the province they undertake to teach. Old errors are propagated from treatise to treatise, and the really knotty points are slurred over as if the province of the science itself was as well defined as that of plane geometry. This confusion is doubtless due to the slavish adherence of the human mind to traditional precepts; accordingly when the expansion of the sciences called for the recognition of hitherto neglected modes of reasoning, the new methods were simply tacked on to the old, without any perception of incoherence or felt need of enlarging the list of fundamental principles.

The first essential for clearness is to distinguish between pure logic and real logic: that is, between those inferential processes which deal with given premisses, and those methods of arriving at truth which cannot be comprehended without a full understanding of the subject-matter. The former half of the science is closely analogous to algebra, and is occupied with the equivalence of convertible statements and the establishment of relations through the media of common terms. Although a seemingly elementary exercise, the practice of deriving equivalent truths from other truths is one which, if thoroughly familiar, would save a great deal that passes for very forcible reasoning.

The venerable type of Reasoning known as the Syllogism, where from two truths, of which one, at least, is universal, a third truth is derived, has of late in some quarters received scanty respect, and as a transcript of common argumentation undoubtedly has but little to say for itself; but if treated as the formal aspect of a real Deduction, will never lose its importance.

The department of Pure, or Formal Logic, requires for its mastery a large practice of examples. If it be desirable to put the youthful intellect through an algebraic text-book, where the real value of the symbols employed is hardly ever explicitly considered, *a fortiori* one would think it should be well to see the laws of consistent thinking illustrated in the language of everyday life. But the student-preceptor, for his part, will not stop here. Having mastered the mysteries of the syllogism, the consideration of the nature of truth itself will be forced upon his mind, and he will be driven to take note of that all-important distinction between real and verbal truth, between truth of mere thought and truth of fact. When the wide interval between these two kinds of truth has become clear to him, he will be prepared to pass on to the study of that other department, which I have designated Real Logic, where we seek to obtain an insight into those rules whereby we do not simply achieve a harmony with ourselves in the recesses of our private consciousness, but endeavour to secure an agreement with the thoughts of all other minds.

Objective, or Real Logic, presupposes that there are Laws of Nature—Uniformities of Succession and Coexistence; and the office of the science is to shape our belief in accordance therewith. Pure, or Formal Logic, is a science regulative of *Thinking*. Self-consistency is its end and aim, and error means overstepping the limitations and conditions inherent in the thinking faculty itself. It usually takes the form either of implicitly denying that a part of a part is a part of the whole, or of in effect asserting that the mind can unite contradictory attributes in an indivisible act of thought. Hence, with full consciousness, a fallacy of pure reasoning is impossible. Thinking signifies no other than direct or mediate comparison of ideas. But while we cannot combine or disjoin the materials of thought erroneously, except by inadvertence, it is quite possible to *believe* mistakenly, even with the fullest development of self-consciousness. To regulate belief, there is no resource but to study the order of the world, and to submit to the teaching of Experience. Now, the rules of Material Logic are nothing but safeguards for the preservation of the mind's sanity in this perilous pursuit. In other words, it is pretty well equivalent to 'The Theory of Evidence.' To ascertain what sort and amount of evidence is sufficient for an assertion, when we are entitled to universalize a limited experience; to graduate assent according to some more reliable principle than the strength of the impulse to credulity or incredulity itself—such, in brief, is the end of this truly difficult, but most necessary discipline.

(To be continued.)

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Friedrich Fröbel.

BY HIS PUPIL, HEINRICH HOFFMAN.

X.—(*continued.*)

These heretics were to be expelled from the country. The friends had but a narrow escape from personal violence, and, of course, considered it high time to provide for their own safety. So Barop proceeded to the seat of the Government, to seek protection.

Most cordially was he received by the leading members of the Council. The high merits of the petitioners were duly acknowledged. 'It is a hopeless struggle,' said the President, Herr Pfyffer, 'that struggle of yours against ignorance and superstition. There is only one means to provide for your safety: convince the masses by an examination, as thorough and as public as possible, of the excellence of your system, and your enemies will be silenced if not subdued. Then, and then only, will you be safe.'

That sage advice met with a hearty response. The petty warfare had been minutely chronicled in the public papers; it was canvassed in every nook and corner of Switzerland, and the impending battle excited the liveliest interest among all classes.

It was a beautiful day in the autumn of 1833 when the long and anxiously awaited trial took place. In countless numbers the people assembled from far and near, even from Zurich and from Bern. The cantonal Governments sent deputies. From seven o'clock in the morning until seven in the evening the most rigorous examination was held. The boys entered upon their task with so much animation and delight, they answered all the questions in so frank and so unembarrassed a manner, that all present were astonished, and in rapturous acclamations gave vent to their joyful surprise; but when the drilling exercises and the games came off, the countenances of the parents beamed with pride and delight, and the general enthusiasm knew no bounds. The battle was won, and Fröbel's victory was complete and decisive.

Enthusiastic speeches were delivered by Pfyffer, Amrhyn, and others, the members of the governing Councils. The matter was considered in an official Council, and the chateau was granted at a merely nominal rent. The Capucins, who had desecrated the pulpit by preaching sedition and violence, were ignominiously expelled from the country.

Not long after, a deputation came from the Canton of Bern, requesting Fröbel to establish a school in the orphan-house at Burgdorf, the very same place where Pestalozzi's star had risen. Fröbel proposed not to confine the plan to orphans only, and this suggestion was readily accepted. It was arranged that Middendorf should take Fröbel's place in Willisau, and be assisted by Ferdinand Fröbel, whilst Langethal, who had followed his friend to Switzerland, accompanied Fröbel to Burgdorf. Barop, considering his mission completed, returned to Keilhau. For a full year did that man leave home and wife, in obedience to the Divine call within him! Shortly after his departure a child had been born to him, whom he had not yet seen. Fröbel himself had sacrificed his family life while in Wartensee, since his wife could not be spared from Keilhau; Middendorff left his wife and his young family for four years, until the Willisau establishment was summarily suspended, when the Jesuitical party secured the reins of government! What remarkable instances of faithful devotion to the sacred cause which these men had espoused! 'When I now come to think of it,' Middendorff used to say, 'I hardly understand how it could have been done, yet I felt like a soldier in war at a dangerous post, I could not and dared not give way. The clergy advanced too fiercely, and with their heaviest cannon, and how could I have thought of running away on mere personal considerations?'

After all his changes and meanderings he seemed to have reached, at Burgdorf, the long-hoped-for safe port. What he had imagined his special calling—a sphere of labour like that of Pestalozzi, yet entirely shaped to his own ideas—he found here open before him. Step by step he had been patiently climbing up the steep mountain, and now that he had reached what he had considered the summit, he discovered a still higher peak, one which fascinated his whole being. Here it was that, in the summer of 1835, Fröbel and Langethal entered upon their duties. Fröbel was appointed director of the Orphan-house, and, as such, had also to superintend the studies of the teachers of the canton. These enjoyed, every third year, a three months' vacation, to repeat and continue their educational studies at Burgdorf under their now far-famed master. That was a glorious time for Fröbel and his wife. Never in all their lives did they feel happier and more at ease. Unmolested by secret or open enemies, unfettered in his labours by official meddling, unoppressed by worldly cares, Fröbel's great mind expanded and revelled in his own world of educational and philanthropical aspirations.

Here it was that he arrived at a new stage of his eventful life. In his intercourse with so many teachers he gained a deeper insight into the inner life of school and family. The latter especially he learned more emphatically to look upon as the real, the all-important keystone of human progress. He was convinced that the family, and not the school, ought to be considered in the first place, and that the school could not prosper unless the family had properly paved the way. Mothers are the first trainers of mankind; to their pure hands are entrusted the highest interests of civilisation, and mothers must be trained for their high calling. This now became his watchword.

This was not a new idea: Napoleon had long ago expressed the same thought to Madame de Campan. Besides, there is no such thing to be found as a new principle in education. Truth may be clothed in a new garb, and may be brought home by new means, or new pathways, but truth itself is eternal.

'The family, the family,' now began to occupy all his thoughts. 'The spiritual must be embodied in materials, in order to develop the child in conformity and in unity with God, with nature, and with mankind!' A good many such materials he had already invented and planned; but where was the beginning to be? The primary, where was it to be found? Which was naturally the first plaything? which the first joyful pastime of the child?

Like a divine inspiration the answer flashed upon him, when once his eye fell upon a party of children playing at ball. Yes, of course! Was not the globular the primary form of all life in nature? And, since all life (in nature) is one, all obeying the same laws, and since the child is part and parcel of nature, must not his development strictly obey the same laws?

The starting-point once found, it was to Fröbel an easy matter to reach his old familiar basis. The 'law of opposites' left him no doubt about it: the ball, the cube, and the intermediate link, the cylinder, these were the three original forms, the very elements of all mechanical contrivances. The subject fascinated him, he was as if in an enchanted garden; the crowning of all his life's labours and aspirations appeared to him an unmistakable reality. *The child at home* seized his imagination—held him spell-bound—him, that no child called father, and made him proclaim to all the

world: 'The whole is foreshadowed in the part, the general in the particular, the man is like an embryo in the child.* All human development has its germs in early childhood; the life of man is the necessary outcome of his treatment as a child! Come, let us live for our children!'

Through all seeming errors and mistakes, through all his many vicissitudes, and disappointments, and trials, he had been most carefully trained for the peculiar purposes of Providence. There was, however, this warning voice of calm reasoning: Might he not be justly charged with inconsistency, when he, ever restless, again changed his sphere of action? After so many grave experiences, might not the voice of worldly wisdom have a just claim to his earnest attention, or were idealistic aspirations to have for ever an unchecked sway over him?

By a supreme decree that natural struggle, if it ever was allowed to occupy his thoughts long, was soon terminated by a dark and dismal cloud.

(To be continued.)

Chemistry of the Non-Metallics.

BY EDWARD AVELING, D.SC. LONDON.

[This series of articles, whilst dealing with the subjects required by the University of London for the Matriculation Examination and with those required at the Elementary Stage of the Inorganic Chemistry (Branch X.) Science and Art Department, is intended as a practical guide to the philosophical and systematic study of the non-metallics.]

EXAMPLES ON BOYLE'S LAW (*for Solution*).

(9) Twenty cubic centimetres of gas are measured off under normal pressure. The pressure is increased 140 millimetres. What is the volume of the gas?

16⅔ cc.

(10) The pressure is equivalent to 3040 millimetres. It is reduced to 3000 millimetres less. Find the change of volume undergone by 80 cubic centimetres.

Expansion = 6 cubic decimetres.

(11) Three litres of gas are to be reduced to 500 cubic centimetres. If the original pressure is 1½ kilograms, find the final pressure.

9 kilograms.

(12) A Boyle's tube has a short limb with length = 1 decimetre. Find (*a*) the difference of level of the mercury that has been poured into the tube; (*b*) the whole length of mercury in the tube when the mercury in the short limb is 4 centimetres from the closed end.

1140 mm.; 1260 mm.

(13) What is the length of the short limb of such a tube that when altogether 2400 millimetres length of mercury have been poured in, the air in the short limb may occupy 2 centimetres length?

8 cm.

The general principle spoken of on page 11, can now be considered. It is found, as the result of experiment, that

gram.		mm.		litres.
1 hydrogen at 0° C, and under		760	pressure, occupies	11·2
16 oxygen	,,	,,	,, occupy	,,
14 nitrogen	,,	,,	,, ,,	,,

Compare the numbers 1, 16, 14 with those in the list on page 12 opposite hydrogen, oxygen, nitrogen. They are identical. And, generally, *the number of grams of any element gas represented by the weight-number of the element occupy at normal temperature, and under normal pressure, 11·2 litres.* This special volume, 11·2 litres, is often called 1 volume or a volume.

* 'The child is father to the man.'—*Wordsworth.*

EXERCISES ON THE LAW OF VOLUMES AS REGARDS ELEMENTS (*Solved*).

N.B.—Unless any statement is made to the contrary the pressure and temperature are assumed to be normal.

(24) The number of litres occupied by 71 grams chlorine gas at 0° and 760 mm.

35½ grams Cl. occupy 11·2 litres

1 gram Cl. occupies $\frac{11\cdot2}{35\cdot5}$,,

71 grams Cl. occupy $\frac{11\cdot2}{35\cdot5}\times 71 = 22\cdot4$ litres.

(25) The number of cubic centimetres occupied by 77 grams nitrogen (at normal).

14 grams N. occupy 11·2 litres = 11,200 cc.

1 gram N. occupies $\frac{11200}{14}$ cc.

77 grams N. occupy $\frac{11200\times 77}{14} = 61{,}600$ cc.

(26) The volume occupied by 80 grams oxygen (at normal).

16 grams oxygen occupy 11·2 litres

1 gram O. occupies $\frac{11\cdot2}{16}$,,

80 grams O. occupy $\frac{11\cdot2\times 80}{16} = 56$ litres.

EXAMPLES ON THE LAW OF VOLUMES AS REGARDS ELEMENTS (*for Solution*).

(14) The volume occupied by 1 decigram hydrogen 1·12 litres.

(15) The volume occupied by 1 gram oxygen ... 7 decilitres.

(16) Weight of 1 litre nitrogen ... ... 1·25 grams.

(17) Weight of 3 cc. hydrogen ... ... $\frac{1}{11\frac{1}{2}}$ grams.

We return to our first typical equation that represents the formation of hydrogen from zinc and sulphuric acid, and write under the symbols the weight-numbers as calculated on page 81, and the volume of the only gas concerned, hydrogen. A volume = 11·2 litres.

$$Zn + H^2So^4 = ZnSo^4 + H^2$$
$$65 + 98 \quad = 161 \quad + 2$$
$$\text{2 vols.}$$

Fully translated, therefore, this means that 65 parts by weight (say grams) of zinc treated with 98 parts by weight of sulphuric acid yield 161 parts by weight of zinc sulphate + 2 parts by weight or 2 volumes (say twice 11·2 litres) of hydrogen.

EXERCISES ON THE PREPARATION OF HYDROGEN FROM ZINC AND SULPHURIC ACID (*Solved*).

(27) Required 56 litres of hydrogen. What weight of zinc must be used?

2 vols. = 22·4 litres hydrogen require 65 grams zinc.

1 litre ,, requires $\frac{65}{22\cdot4}$,,

56 litres ,, require $\frac{65\times 56}{22\cdot4} = 162\frac{1}{2}$ grams zinc.

(28) 77 grams sulphuric acid are poured on a mass of zinc. What weight of the metal is dissolved and what volume of hydrogen is given off?

98 grams H^2So^4 dissolve 65 grams Zn. and liberate 22·4 litres H.

1 gram ,, dissolves $\frac{65}{98}$,, ,, ... $\frac{22\cdot4}{98}$,,

77 grams ,, dissolve $\frac{65\times 77}{98}$,, ,, ... $\frac{22\cdot4\times 77}{98}$,,

51·½ grams zinc, 17·6 litres hydrogen.

EXAMPLES ON THE PREPARATION OF HYDROGEN FROM ZINC AND SULPHURIC ACID (*for Solution*).

(18) 26 grams of zinc are dissolved in sulphuric acid. What volume of hydrogen is evolved? ..... 8·96 litres.

(19) Required 8occ hydrogen. What weight of zinc sulphate is formed at the same time? ..... 111½ grams.

(20) 1 kilogram, 3 hectograms zinc are dissolved. Find weight and volume of hydrogen evolved.

4 decagrams : 4 hectolitres, 4 decalitres, 8 litres.

To sum up all that should be learned from this first preparation of the element hydrogen.

(*a*) The laboratory method of preparing it (page 81).
(*b*) The symbols $Zn + H^2SO^4 = ZnSO^4 + H^2$.
(*c*) The metric system of weights and measures (page 119).
(*d*) The weight numbers in the reaction $Zn(65) + H^2SO^4(98)$ yield $ZnSO^4(161)H(2)$.
(*e*) Thermometers.
(*f*) Barometers.
(*g*) Boyle's law.
(*h*) The law of volumes as regards elements.
(*i*) The volume in this reaction H_2 (2 vols., or 22·4 litres) are evolved when 65 grams of zinc and 98 grams of sulphuric acid are placed together under appropriate conditions.

SECOND PREPARATION. FROM WATER AND POTASSIUM OR SODIUM.

(1) Laboratory method. Prepare a pneumatic trough, beehive, and gas jars as directed on page 81. Place in the water a piece of red and a piece of blue litmus paper. These are blotting-paper stained with certain vegetable colours. Also a piece of turmeric paper, which is paper stained yellow with an extract from the turmeric root. Note that the colour of none of these three pieces of paper is changed by the water. Taking care that your fingers are dry, cut off with a dry knife a piece of the soft metal potassium. Place it within a cage made by folding together a piece of wire gauze with meshes not too fine. Hold the cage by means of a strong wire—about twelve inches long. Taking an inverted gas-jar filled with water in one hand plunge with the other the cage containing the potassium beneath the surface of the water and below the mouth of the jar. The potassium decomposes the water, taking the place of part of the hydrogen in that compound, and forming a new compound of potassium, hydrogen, and oxygen, called potassium hydrate, or potassium hydroxide, or, commonly, caustic potash. I prefer the first name, for reasons that will be better understood by and by. The hydrogen gas set free bubbles up into the gas-jar, displacing the contained water. The blue litmus paper is unchanged; the red is turned blue, and the yellow turmeric paper brown. Hydrogen oxide (or water) and potassium have yielded potassium hydrate and hydrogen. If sodium is used instead of potassium, sodium hydrate, or sodium hydroxide, or caustic soda is formed.

(2) Symbols $2H^2O + 2K = 2KHO + H^2$ (*good*).

The student will note that the reaction might *apparently* be represented by exactly halving the symbols, and writing—

$$H^2O + K = KHO + H \text{ (\textit{bad})}.$$

But this would give us a symbolic representation of the evolution of *one* atom of hydrogen. And on the views at present held by chemists a single atom of an element gas cannot exist alone. An *atom*, represented by the symbol of the element written alone, without any figure, is the smallest part of an element which can exist in combination. Thus potassium hydrate consists of three atoms, one of potassium, one of hydrogen, and one of oxygen. A *molecule* (moles = mass, icula = diminutive ending), or little mass, is the smallest part of an element, or compound, that can exist alone. Usually, a molecule consists of two atoms. Thus H^2 represents a molecule of hydrogen. In representing reactions by symbols, care must be taken never to represent a single atom of an element gas as existing alone. This only applies to gases. A solid or liquid element may be represented by its symbol without any figure. Thus in the bad equation given above K is not incorrect, and in the good equation 2K is written, but H^2.

(3) *Weights and volumes.* A reference to the table on page 12 shows that the weight-numbers of potassium and sodium are respectively 39 and 23.

$$\begin{array}{rcrcrcl} 2\,H^2O & + & 2\,K & = & 2\,K\,H\,O & + & H^2 \\ \underbrace{2\,(2+16)} & + & \underbrace{2\times 39} & = & \underbrace{2\,(39+1+16)} & + & 2 \\ 36 & + & 78 & = & 112 & + & 2 \end{array}$$

2 vols.

36 parts by weight (say grams) of water into which 78 parts by weight of potassium are plunged yield 112 parts by weight of potassium hydrate and 2 parts by weight, or 2 parts by volume, of hydrogen.

$$\begin{array}{rcrcrcl} 2\,H^2O & + & 2\,Na & = & 2\,Na\,H\,O & + & H^2 \\ \underbrace{2\,(2+16)} & + & \underbrace{2\times 23} & = & \underbrace{2\,(23+1+16)} & + & 2 \\ 36 & + & 46 & = & 80 & + & 2 \end{array}$$

2 vols.

EXERCISES ON THE PREPARATION OF HYDROGEN FROM WATER AND POTASSIUM OR SODIUM (*Solved*).

(29) Required 1 gram hydrogen. What weight of water will be decomposed?

2 grams H yielded by 36 grams H^2O
1 gram ,, ,, ,, $\frac{36}{2}$,, ,,

18 grams.

(30) Upon a litre of distilled water a number of small pieces of sodium are thrown, weighing in all 2 kilograms. What weight of hydrogen is evolved, and what weight of water or of metal is left at the end of the experiment?

1 litre of water = 1000 cc. = 1000 grams.
36 grams H^2O need 46 grams Na and evolve 2 grams H
1 gram ,, needs $\frac{46}{36}$,, ,, ,, evolves $\frac{2}{36}$,, ,,
1000 grams ,, need $\frac{46\times 1000}{36}$,, ,, evolve $\frac{2\times 1000}{36}$,,

$1277\frac{7}{9}$ grams Na are required and
$55\frac{5}{9}$,, H ,, evolved.
∴ $2000 - 1277\frac{7}{9}$ grams Na are left.

$722\frac{2}{9}$ grams Na, $55\frac{5}{9}$ grams left H evolved.

(31) As result of throwing potassium on water $2\frac{1}{2}$ grams hydrogen are evolved. What weight of potash is formed?

2 grams H are evolved when 112 grams KHO are formed.
1 gram ,, is ,, ,, $\frac{112}{2}$,, ,, ,,
$\frac{1}{2}$ grams ,, are ,, ,, $\frac{112\times 5}{2\times 2}$,, ,, ,,

140 grams.

(*To be continued.*)

ANSWERS TO ARITHMETICAL QUESTIONS IN THE 'LITTLE LEARNER' FOR AUGUST, 1884.

STANDARD I.

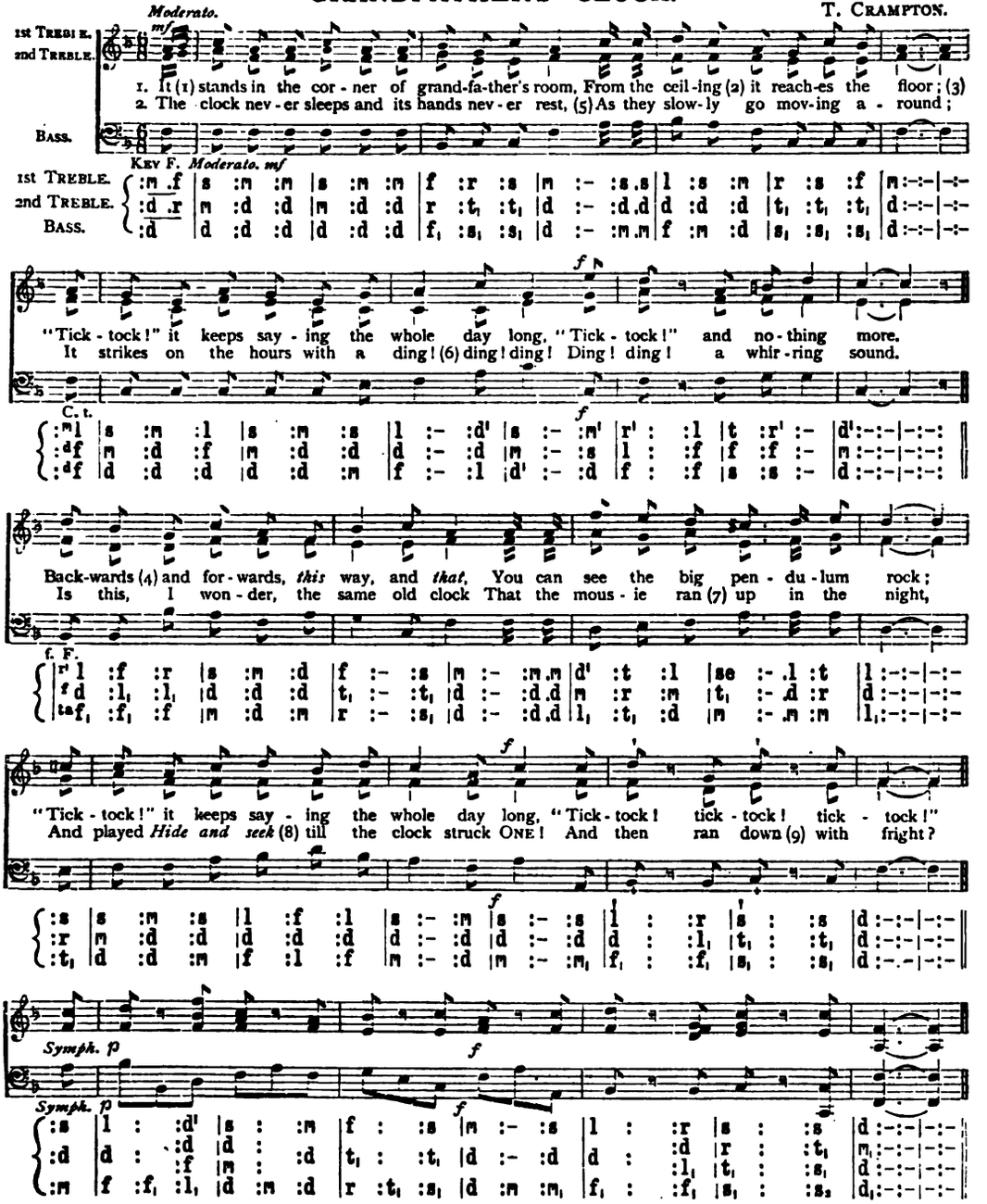
(1) 2895
(2) 701
(3) 181
(4) 2849
(5) 293
(6) 195
(7) 803
(8) 90
(9) 483
(10) 2304
(11) 2699
(12) 5698
(13) 4239
(14) 244
(15) 92
(16) 3962
(17) 91
(18) 8
(19) 1738
(20) 591
(21) 698
(22) 3846
(23) 221
(24) 106
(25) 4265
(26) 95
(27) 357

STANDARD II.

A. 1. 376,721
2. 259,137
3. 191,852
B. 1. 29,384
2. 10,266
3. 13,033
C. 1. 511,101
2. 434,148
3. 628,271
D. 1. 1,387,020
2. 733,266
3. 7,120,036
E. 1. 69,566,280
2. 47,577,690
3. 108,831,400
F. 1. 2567
2. 6789+7
3. 4467+6
G. 1. 4,630+2
2. 8,252+8
3. 2,105+6
H. 1. 769+67
2. 550,817,000
3. 29,577,924
I. 1. 515,612,600
2. 197,102,950
3. 581,454,720

GRANDFATHER'S CLOCK.

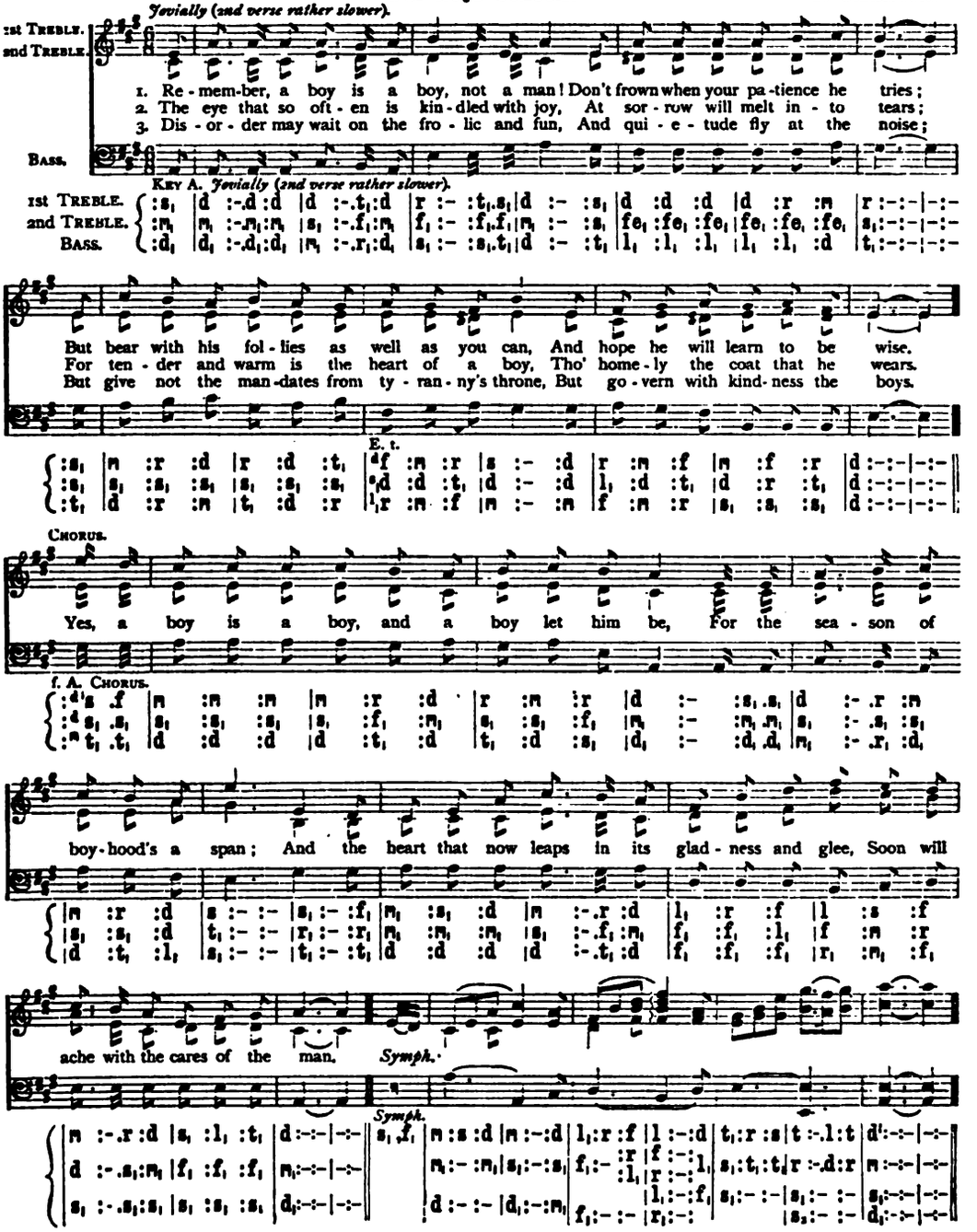
T. CRAMPTON.


Moderato.
mf
1st TREBLE.
2nd TREBLE.
BASS.
1. It (1) stands in the cor - ner of grand-fa-ther's room, From the ceil-ing (2) it reach-es the floor; (3)
2. The clock nev - er sleeps and its hands nev - er rest, (5) As they slow-ly go mov-ing a - round;
KEY F. Moderato. mf
"Tick - tock!" it keeps say - ing the whole day long, "Tick - tock!" and no - thing more.
It strikes on the hours with a ding! (6) ding! ding! Ding! ding! a whir - ring sound.
C. t.
Back-wards (4) and for - wards, this way, and that, You can see the big pen - du - lum rock;
Is this, I won - der, the same old clock That the mous - ie ran (7) up in the night,
f. F.
"Tick - tock!" it keeps say - ing the whole day long, "Tick - tock! tick - tock! tick - tock!"
And played Hide and seek (8) till the clock struck ONE! And then ran down (9) with fright?
Symph. p
Symph. p

(1) Point to the corner of the room. (2) Point upwards. (3) Point downwards. (4) Swing the right hand and arm to and fro. (5) Move fingers slowly round. (6) Strike the desk with the right hand. (7) Move the hands upwards and the fingers quickly. (8) Hold both hands before the eyes. (9) Move hands downwards with fingers moving rapidly.

A BOY IS A BOY.

For Boys' Schools. T. CRAMPTON.


Jovially (and verse rather slower).
1st Treble.
2nd Treble.
1. Re - mem-ber, a boy is a boy, not a man! Don't frown when your pa-tience he tries;
2. The eye that so oft - en is kin - dled with joy, At sor - row will melt in - to tears;
3. Dis - or - der may wait on the fro - lic and fun, And qui - e - tude fly at the noise;
Bass.
Key A. Jovially (2nd verse rather slower).
1st Treble.
and Treble.
Bass.
But bear with his fol - lies as well as you can, And hope he will learn to be wise.
For ten - der and warm is the heart of a boy, Tho' home - ly the coat that he wears.
But give not the man-dates from ty - ran - ny's throne, But go - vern with kind - ness the boys.
E. t.
Chorus.
Yes, a boy is a boy, and a boy let him be, For the sea - son of
f. A. Chorus.
boy - hood's a span; And the heart that now leaps in its glad - ness and glee, Soon will
ache with the cares of the man.
Symph.
Symph.

Physiology.

BY ARTHUR NEWSHOLME, M.D. LOND.,

Gold Medallist and University Scholar, Physician to the City Dispensary.

CHAPTER X.—THE BLOOD.

IN considering the circulatory system, it will be convenient to study first the blood and its properties; then the anatomy of the heart and blood-vessels; and, finally, the mechanism of the circulation.

The blood is a tissue which differs from other tissues in not being fixed to one part. It may be compared to cartilage, the cartilage-cells being represented by the blood-corpuscles, while the matrix of the cartilage has become fluid, thus allowing free movement of the corpuscles.

When blood is seen directly after its escape from the blood-vessels, it is a viscid opaque liquid, varying in colour from deep purple to bright scarlet, and having a distinct though slight odour, which varies in different animals. It gives an alkaline reaction to litmus paper, and has an average specific gravity in man of 1055 (water = 1000).

The *quantity of blood* is difficult to estimate. One of the most reliable methods of estimating it is to kill an animal, and rapidly empty its blood-vessels by bleeding it. Next wash out the vessels with water, and collect and mix the washings. A known quantity of blood is then diluted with water until it possesses the same tint as a measured specimen of the washings. From this the total amount of blood in all the washings can easily be estimated. Finally, the whole body is carefully minced up, and washed free from blood. The amount of blood in these washings is estimated as before. This, added to the amount calculated from the previous washings, and to the amount of escaped blood, gives the total quantity of blood in the body, which is generally found to be about $\frac{1}{13}$ of the body weight. Even in this method slight fallacies exist, but it may be taken as approximately correct.

Broadly, the *distribution of the blood* is as follows:—

About one-fourth in the heart, lungs, large arteries and veins,
" " " liver,
" " " muscles of the skeleton,
" " " other organs.

It is evident, therefore, that the most important changes in the blood must occur in the liver and the muscles.

If a drop of blood be examined microscopically immediately after its escape, it will be seen to consist of two parts—a *liquor sanguinis or plasma*, and *corpuscles*. When a quantity of blood escapes it soon begins to readjust its constituents. A new element which did not exist as such in blood is produced (*fibrin*), which entangles the blood corpuscles, and thus produces the *crassamentum* or clot.

Liquid blood { liquor sanguinis { serum, fibrin } ; corpuscles . . . . . } clot.

The *corpuscles* of the blood are of two kinds, commonly known as red and white, the former being by far the most numerous. On an average there are from 400 to 500 red to one white corpuscle, though the proportion varies in different parts of the body. In the splenic vein, the proportion is about 70 to 1. At different parts of the day the proportion varies, the number of white corpuscles being increased by a meal.

The *white corpuscles* are not so regularly circular as the red. When seen under the microscope, they refract the light owing to the presence of a nucleus, which is rendered much more evident by the addition of a drop of acetic acid to the slide. They average $\frac{1}{2500}$ inch in diameter.

Their most remarkable property is that of assuming different shapes when watched under the microscope in blood serum which is kept at the temperature of the body. These amœboid movements are analogous to the movements exhibited by the amœba, to which reference has been previously made.

The *red corpuscles* are somewhat smaller than the white, averaging $\frac{1}{3200}$ inch in diameter. They are circular in outline when flat, but slightly biconcave when seen edgewise. When seen directly after withdrawal from the body they appear quite homogeneous, showing no cell-wall or nucleus. In colour they are pale yellow when seen singly, deep red when seen *en masse*.

They possess a great tendency to adhere together into rolls or columns (rouleaux), like piles of coins,

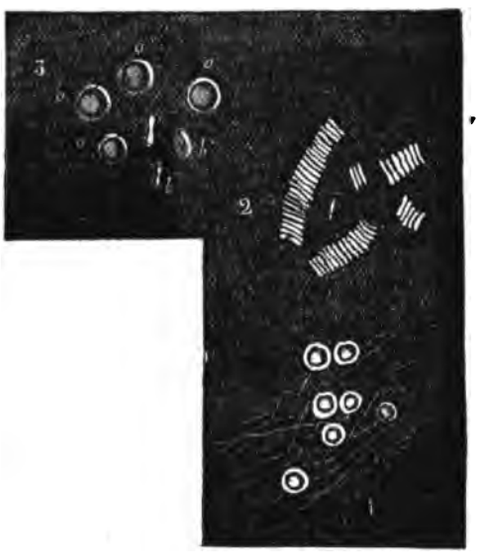


Fig. 41.—Red Corpuscles much magnified; (1) enclosed in meshes of fibrin during coagulation; (2) collected into rouleaux; (3) showing the biconcave discs, (*a*) flat, (*b*) edgewise.

and then these piles become clustered together in irregular masses. This aggregation of the corpuscles increases their specific gravity, and so makes them sink more rapidly in blood which is kept in a basin.

The red corpuscles are very short-lived. The slightest evaporation causes them to shrivel, assuming an indented or crenated edge. Oxygen gives them a sharper outline and brighter colour. Carbonic acid causes them to swell and become opaque towards the centre. By an induced electric current a fibrillated appearance is produced. When a solution of magenta is added to blood, the magenta becomes deposited towards the centre of the red corpuscles, which is probably less dense than their exterior. Boracic acid causes a distinct differentiation of the substance of the corpuscle.

Chemically considered, 100 parts of wet red corpuscles consist of 56·5 parts of water, and 43·5 of solid matter.

The inorganic material in the solids of corpuscles amounts to less than 1 per cent. It consists chiefly of potassium chloride and phosphate.

Of the organic matter of the corpuscles, hœmoglobin forms 90·5 per cent., other proteid substances 8·7, there being only minute quantities of the remaining substances, lecithin and cholesterin.

Hæmoglobin, when separated from the other constituents of red corpuscles, is readily soluble in water and in serum. This being so, it is evident that there must be in the blood some intimate combination between the stroma and the hœmoglobin of the corpuscles, which prevents the latter being washed away. In preparing hœmoglobin it is necessary to break up the corpuscles, by the addition of chloroform or by alternate freezing and thawing. An aqueous solution of hœmoglobin can then be obtained.

Hœmoglobin from the blood of the rat, horse, dog, and some other animals, crystallises readily in slender four-sided prisms. The crystals from the guinea-pig's blood are octahedral, those from the hedgehog are six-sided plates; while the blood of the ox, sheep, pig, and man crystallises with difficulty.

The most important property of hœmoglobin is its power of entering into a loose chemical combination with oxygen, forming *oxy-hæmoglobin*. This change is constantly occurring in the lungs, where the reduced hœmoglobin of venous blood is acted upon by the oxygen of the air in the pulmonary vesicles. The oxy-hœmoglobin is carried to the various tissues of the body, which rob it of its oxygen.

When a dilute solution of hœmoglobin is placed before a spectroscope, it absorbs certain rays of light in a characteristic manner. Two marked absorption bands appear between the solar lines D and E, the one towards the red side being narrower and darker than the one towards the blue side, which shades away more gradually. The position and appearance of these bands is a certain test for oxy-hœmoglobin.

The oxygen of oxy-hœmoglobin may be removed by exhaustion under an air-pump, or by a reducing agent, such as ammonic sulphide.

The reduced hœmoglobin differs spectroscopically in appearance from oxy-hœmoglobin. The two absorption bands have disappeared and been replaced by a single much broader band, intermediate in position. If the reduced hœmoglobin is exposed to air, it absorbs oxygen and reassumes the spectrum of oxy-hœmoglobin. The different colour of venous and arterial blood is due to the presence of a smaller amount of oxy-hœmoglobin in the former than the latter.

Hœmoglobin combines with other gases as well as oxygen, when exposed to their influence. Thus with carbonic oxide it forms a more stable compound than with oxygen. If a large number of red corpuscles form this compound (as occurs in poisoning by the fumes of burning charcoal) oxidation changes in the tissues are prevented, and poisoning rapidly occurs.

Although capable of crystallisation, hœmoglobin is but slightly diffusible. This is owing to its consisting in part of a proteid body (globin), which is associated with a coloured body (hæmatin). The proteid material is coagulated by heating a solution of hœmoglobin, hæmatin being liberated, which possesses a well-marked spectrum. Hæmatin is a dark brown powder, of which the composition is probably $C_{32}\ H_{34}\ N_4\ Fe\ O_5$. By the action of strong sulphuric acid, it is deprived of its iron, and is no longer capable of combining loosely with oxygen. The iron seems therefore closely associated with the respiratory function of hœmoglobin.

The red corpuscles are derived from white corpuscles, which are being constantly produced by multiplication from the leucocytes of lymphoid tissue all over the body. There can be little doubt that the nucleus of the white corpuscle breaks up and disappears, its protoplasm being converted into hœmoglobin and stroma. According to Wharton Jones and Huxley, however, the nucleus of the white corpuscle becomes the red corpuscle, the rest of it disappearing.

The red corpuscles have been already stated to be short-lived. They are being constantly formed from white corpuscles, in the spleen and elsewhere; while at the same time other red corpuscles become broken down and disintegrated. The spleen plays an active part in this change likewise. The ultimate destination of the derivatives of hœmoglobin is somewhat doubtful; but it seems certain that *hæmatoidin* crystals, which are commonly contained in old blood-clots and are a derivative of hœmoglobin, are identical with the bilirubin of bile. It seems probable that the urinary pigment has a similar origin, though the connection has not been traced.

Proof of the short-lived character of the red blood corpuscles is furnished by their varying number at different parts of the day, and by the fact that when the blood of one animal is injected into the veins of another, the foreign corpuscles soon disappear.

(*To be continued.*)

ANSWERS TO ARITHMETICAL QUESTIONS IN 'THE SCHOLAR' FOR AUGUST, 1884.

STANDARD III.

A. 1. 9443+12.
2. 15,504+36.
3. 20,085+45.

B. 1. 25,660+24.
2. 5513+42.
3. 1424+29.

C. 1. 750⅜+7.
2. 9012+49.
3. 14,395+148

D. 1. £256 12s. 1d.
2. £244 9s. 7½d.
3. £18,651 4s. 3½d.

E. 1. £49 10s. 2½d.
2. £6490 0s. 0⅜d.
3. £7 12s. 2½d.

STANDARD IV.

A. 1. £57 17s. 9½d.+49.
2. £305,309 17s. 3½d.
3. 1,000,000.

B. 1. 13,644.
2. £1 12s. 1½d.
3. £451 4s. 1⅜d.

C. 1. £196 13s. 8⅜d.+17.
2. 141,283.
3. 897,120.

D. 1. £443 6s. 8d.
2. 2880.
3. £9 14s. 9½d.

E. 1. £5,669,579 10s. 1d.
2. £14 5s. 9d.
3. 200 times.

F. 1. 392.
2. 67,000 guineas.
3. £4 1s. 9½d.

STANDARD V.

A. 1. £36 3s. 6½d.
2. £3090 7s. 6d.
3. £6730 15s.

B. 1. $1\frac{3}{16}$.
2. £10 7s. 6d.
3. £5809 4s. 4½d.

C. 1. £24 5s. 9½d.
2. £329 3s. 4d.
3. 120 yds.

D. 1. $\frac{9}{16}$.
2. £3 1s. 6d.
3. 25.

E. 1. $1\frac{1}{16}$.
2. £11 4s. 5½d.
3. £7096 13s. 4d.

F. 1. £15 15s. 11⅜d.
2. £412.899 4s. 6d.
3. £10 8s. 6½d.

STANDARD VI.

A. 1. ⅔.
2. £24 18s. $4\frac{8}{11}$d.
3. $7\frac{3}{13}$.

B. 1. 3s. 6d.
2. ·1946428571.
3. (*a*) ·021015.
(*b*) 1250.

C. 1. 16 men.
2. 10 ozs. 10⅔ drs.
3. 300 pages.

D. 1. ·142857.
2. £8,273,280.
3. 63 ft.

E. 1. $\frac{28}{45}$.
2. 5s.
3. £44 11s. 11⅜d.

$\frac{31}{100}$q.

STANDARD VII.

A. 1. (*a*) 2s. $2\frac{3}{5}$d.
(*b*) 1 cwt. 7 lb.
2. 24.
3. £$1\frac{1}{20}\frac{13}{20}$ or £1 18s. $0\frac{1}{2}$d. p.c.

B. 1. £91.
2. $1\frac{9}{11}$.
3. ·95 or $\frac{1}{20}$.

C. 1. $30\frac{80}{185}$.
2. 13 ozs.
3. £593 15s.

D. 1. Disc. £4 5s. $11\frac{133}{137}$d.
Pres. Val. £245 14s. $0\frac{244}{401}$d.
2. £16 12s. $4\frac{288}{441}$d.
3. 900 p.c.

ANSWERS TO ALGEBRA QUESTIONS IN THE 'SCHOLAR' FOR AUGUST, 1884.

EXERCISE XXXIII.

(1) ± 4
(2) ± 7
(3) ± 2
(4) ± 3
(5) ± 4
(6) $\pm \frac{1}{2}$
(7) ± 5
(8) ± 1
(9) ± 5
(10) $\pm\sqrt{\frac{8}{9}}$
(11) $\pm\sqrt{31}$
(12) $\pm c$

ANSWERS TO Pupil Teachers' Examination Papers.

JUNE 28TH, 1884.

FIRST YEAR.

Pupil Teachers at end of First Year.

Three hours and a half allowed.

Arithmetic.

MALES.

1. Simplify $\dfrac{3\frac{1}{3} - 2\frac{1}{2} \text{ of } \frac{7}{8} \div 3\frac{1}{2}}{6\frac{2}{3} \text{ of } 1\frac{3}{4} - \frac{5}{8}}$

$$\frac{3\frac{1}{3} - 2\frac{1}{2} \text{ of } \frac{7}{8} \div 3\frac{1}{2}}{6\frac{2}{3} \text{ of } 1\frac{3}{4} - \frac{5}{8}}$$

$$= \frac{\frac{10}{3} - \frac{5}{2} \times \frac{7}{8} \div \frac{7}{2}}{\frac{20}{3} \times \frac{7}{4} - \frac{5}{8}}$$

$$= \frac{\frac{10}{3} - \frac{35}{16} \div \frac{7}{2}}{\frac{35}{3} - \frac{5}{8}}$$

$$= \frac{160 - 105}{48} \times \frac{24}{230 - 15} \times \frac{8}{11} \frac{11}{13} = \frac{8}{11} \times \frac{24}{215} \times \frac{11}{13}$$

$$= \underline{\frac{7}{143}}. \text{ Ans.}$$

2. What decimal of 15s. $7\frac{1}{2}$d. is equal to 13s. 6d.?

$$\frac{13\text{s. } 6\text{d.}}{15\text{s. } 7\frac{1}{2}\text{d.}} = \frac{162}{187} = \underline{\cdot 864}. \text{ Ans.}$$

3. Write down in order of magnitude (the greatest first), ·6, ·67, ·667, ·6649, ·665; and find the difference between ·6 and ·6649 without using vulgar fractions.

$$\underline{\cdot 67, \cdot 667, \cdot 6, \cdot 665, \cdot 6649}. \text{ Ans.}$$

$$\cdot 66666\ldots - \cdot 66490 = \underline{\cdot 00176}. \text{ Ans.}$$

4. A bankrupt's assets amounted to £3750, and his creditors lost $\frac{13}{16}$ of their money; what did the bankrupt's debts amount to?

$\frac{16}{16} - \frac{13}{16} = \frac{3}{16}$ frac. rep. assets.

£
$\frac{3}{16} = 3750$
$\frac{1}{16} = \frac{3750}{3}$
$\frac{16}{16} = \frac{3750 \times 16}{3}$
$= \underline{£20{,}000}$. Ans.

FEMALES.

1. Four bells toll at intervals of 3, 7, 12, and 14 seconds respectively, and begin to toll at the same instant; when will they next toll together?

They will toll together in as many secs. as are represented by the L.C.M of 3, 7, 12, and 14.

secs.
L.C.M. of 3, 7, 12, 14 = $\underline{84}$. Ans.

2. What will it cost to drain 18 miles 6 fur. 30 poles at £7 19s. $11\frac{1}{2}$d. per mile?

	£	s.	d.		
4 f. = ½ m.	7	19	$11\frac{1}{2}$	= Cost of 1 mile.	
		18			
	143	19	3	= ,,	18 miles.
2 f. = ½ of 4 f.	3	19	$11\frac{3}{4}$	= ,,	4 fur.
20 p. = ⅛ of 2 f.	1	19	$11\frac{7}{8}$	= ,,	2 fur.
10 p. = ½ of 20 p.	0	9	$11\frac{31}{32}$	= ,,	20 poles.
	0	4	$11\frac{63}{64}$	= ,,	10 poles.
	£150	14	$2\frac{37}{64}$	= ,,	18 m. 6 f. 30 p.

3. Make out the following bill and properly receipt it:—
$13\frac{1}{2}$ yds. ribbon at 1s. $4\frac{1}{2}$d. per yd.
47 yds. calico at $8\frac{1}{2}$d. per yard.
$2\frac{1}{2}$ doz. pair gloves at 2s. 8d. per pair.
5 table cloths at a guinea and half each.
25 reels of cotton at $1\frac{1}{2}$d. per reel.

London, June 28th, 1884.

Mrs. Jones,
Bought of Brown and Robinson.

	£	s.	d.
$13\frac{1}{2}$ yds. ribbon at 1s. $4\frac{1}{2}$d. per yd.... ...	0	18	$6\frac{3}{4}$
47 yds. calico at $8\frac{1}{2}$d. per yd.	1	13	$3\frac{1}{2}$
$2\frac{1}{2}$ doz. pairs of gloves at 2s. 8d. per pair ...	4	0	0
5 table cloths at $1\frac{1}{2}$ guineas each	7	17	6
25 reels cotton at $1\frac{1}{2}$d. per reel	0	3	$1\frac{1}{2}$
	£14	12	$5\frac{3}{4}$

Received £14 : 12 : $5\frac{3}{4}$
Same time
J. B. for Brown and Robinson.

4. What must be added to the sum of $7\frac{8}{10}$, $12\frac{4}{15}$, $4\frac{7}{12}$, $\frac{9}{60}$, and $3\frac{7}{10}$ to make 30?

$$30 - (7\tfrac{8}{10} + 12\tfrac{4}{15} + 4\tfrac{7}{12} + \tfrac{9}{60} + 3\tfrac{7}{10})$$

$$= 30 - 26\frac{54 + 32 + 70 + 27 + 84}{120}$$

$$= 30 - 28\tfrac{27}{120}$$

$$= \underline{1\tfrac{93}{120}}. \text{ Ans.}$$

Grammar.

MALES AND FEMALES.

1. 'I come, I come, ye have called me long;
I come o'er the mountains with light and song.'

(*a*) Say how many sentences there are in these two lines and distinguish the parts of each.
(*b*) Parse all the words in the passage.

(*a*) Four sentences:
(1) and (2) I, *subject*; come, *predicate*.
(3) Ye, *sub.*; have called, *pred.*; me, *obj.*; long, *ext. of pred.*
(4) I, *sub.*; come, *pred.*; o'er the mountains with light and song, *ext. of pred.*

(*b*) *I*—pers. pron., 1st pers., sing. no., com. gen., nom. case to *come*.
come—verb, irreg. intrans., act., ind., pres., sing., 1st per., agreeing with its nom. *I*.
The second and third *I come* are parsed in the same way.
Ye—pers. pron., 2nd pers., plur., com. gen., nom. to *have called*.
have—aux. verb to *called*, indicating perfect tense.
called—past part. of the verb *to call*.
have called—verb, reg. trans., act., ind., perf. 2nd., agreeing with its nom. *ye*.
me—pers. pron., 1st pers., sing., com., obj., gov. by *have called*.
long—adv. of time, qualifying *have called*.
o'er—prep., showing the relation between *mountains* and *come*.
the—distg. adj., limiting *mountains*.
mountains—com. noun, plur., neut., 3rd, obj., gov. by *o'er*.
with—prep., showing rel. between *light* and *come*.
light—com. noun, neut., sing., 3rd, obj. gov. by *with*.
and—cop. conj., joining the sentences 'I come with light,' and 'I come with song.'
song—com. noun, neut., sing., 3rd, obj., gov. by *with*.

2. Explain the meaning and use of the termination *en* in each of the following words, and give other words illustrating the same formation :—

Ox*en*. Drunk*en*. Earth*en*. Hard*en*.

Oxen—en is the plural termination in a few English words. In this case it forms the plural of ox. Other words: child, children; brother, brethren.

Drunken—en is the affix which forms the passive participle of several irregular verbs. It means *made*. Other words: speak, spoke, spoken; choose, chose, chosen.

Earthen—en means *made of*. It forms an adj. from a noun. Other exs.: wood, wooden; gold, golden.

Harden—en means *to make*. It forms a verb from an adj. Other words: soft, soften; weak, weaken.

Geography.

(*Answer either* Q. 1 *or* Q. 2, *not both.*)

1. Draw a map of Australia, inserting the lines of latitude and longitude.

2. Show from the hill system of the British Isles that the most beautiful scenery is to be found where the older rocks exist.

The most beautiful scenery of the British Isles may perhaps be said to be among the Western Highlands of Scotland, in Cumberland and Westmoreland, in N. Wales, and in the Western Highlands of Ireland. These hills are composed principally of granite, felspar, quartz, mica, and hornblende, which geologists class among the oldest or primary rocks. Usually such hills are bleak and barren, but the action of snow, wind, water, and sun has in many places filled the valleys or the sides of the hills with soil which is capable of cultivation or fit for the growth of trees, and there is in these districts a combination of mountain, hill, dale, lake, stream, and waterfall, rendering them the most beautiful in the country.

3. Enumerate the chief rivers of Scotland, and give a particular description of the course of one of them.

The principal rivers of Scotland are the Tweed, Forth, Tay, N. and S. Esk, Dee, Don, Spey, Ness, and Shin, running into the North Sea, the Annan, Nith, Dee, and Esk into the Solway Firth; the Clyde, Irvine, and Ayr, into the Firth of Clyde.

The Clyde is one of the most important rivers of Scotland. It rises in the Lowther Hills in the S. of Lanarkshire and flows in a north-westerly direction through the whole of that county. Its course is then almost due W., and by a wide estuary after a course of ninety-eight miles it empties itself into the Firth of Clyde. After leaving Lanark it separates the counties of Dumbarton and Renfrew. On its banks are Lanark (noted as the centre of the coal and iron district of the county, and near which are the Falls of Clyde, 100 feet in height), Glasgow (the largest town of Scotland), and Greenock (noted for shipbuilding).

4. Give a brief description of the West Coast of Ireland.

The W. coast of Ireland is exposed to the full force of the Atlantic waves and currents, and very much indented, resembling in a remarkable degree the coast of Norway. Its chief openings are Donegal, Sligo Killala, Clew, and Galway Bays, the mouth of the Shannon, Dingle, Kenmare, and Bantry Bays, besides many others. There are numerous islands and rocky islets, the chief being Aran, Achil, Clare, South Aran, and Valentia. The coast is high and rocky, in many places reaching from 1,000 to 2,000 feet. The indentations form good harbours, which are made use of by the fishing population of the W. coast.

5. Describe the position of Quebec, Ottawa, Halifax (N.S.), and give a brief account of the industries of Canada.

Quebec is situated on the N. bank of the river St. Lawrence, about 340 miles from its mouth. It is in the province of Quebec, in the Dominion of Canada, and is built on a promontory which stretches into the river.

Ottawa is at the junction of the Rideau Canal with the river Ottawa, and about 110 miles from the junction of the latter with the St. Lawrence.

Halifax, Nova Scotia, is on the S.E. coast of that province, in lat. 44° N. and long. 64° W. It has an extensive harbour.

Canada is a comparatively new country. Its chief industries are connected with the cultivation of the soil. It produces and exports timber, corn, hemp, wheat, and flour. Its seas in the east supply us with large quantities of fish, including cod, salmon, and lobster. Mines of coal, iron, copper, and lead are wrought in the eastern part of the Dominion, and gold is found in Columbia.

History.

1. What is known about the institutions and employments of the ancient Britons?

The Britons were under monarchical government, being divided into distinct tribes, some of which were known to the Romans as Cantii, Trinobantes, Iceni, and Bibroci. Their religion was Druidism, and consisted in worshipping a plurality of gods, the veneration of the oak and mistletoe, and human sacrifices. Charity towards man and fortitude in suffering were inculcated. Bards sang the praises of their princes, and accompanied their songs with music on an instrument called the Chrotta. The people in the south cultivated their land and exported some of their produce. Mines of copper and tin were also worked. The people of the north were shepherds and herdsmen. They were all trained to bear arms, which consisted of javelin, shield, and sword. Their war-chariots were low and easily mounted. They had no fortified towns, but surrounded their villages with a stockade and moat.

2. What made it necessary for Alfred the Great to establish a fleet?

The incursions of the Danes were so sudden, their training so warlike, and their boldness so great, that Alfred saw clearly if they were to be met they must be attacked not after, but before they reached the shores of this country. To guard, therefore, against future incursions of the Norsemen, Alfred tried to revive the old seafaring spirit of his countrymen, building ships which should be able to encounter the attacks of those of the Vikings of the north, and prevent the devastation of his land in the future.

3. When and how did England first fall under the rule of foreign kings?

The name *England* was not given to this country till the reign of Egbert or Athelstane. The first *foreign* kings who reigned over this country were therefore Sweyn and Canute, Kings of Norway, Denmark, and Sweden. Ethelred the Unready, instead of meeting the Danes as his predecessors had done, endeavoured to buy off their hostility with money, and levied *Danegeld* for that purpose. It succeeded for a time, but incursions became more frequent, and Sweyn, in 1013, made himself master of the country, and reigned for twelve months. He was succeeded by his son Canute.

Composition.

Write from memory the substance of the passage read to you by the Inspector.

It is in the Silver Spring region of Florida that the alligator flourishes, coming out to sun himself at midday on the logs and warm banks at the edge of the river. The alligator is a coward, rarely attacking even the smallest child unless the retreat to water in which to hide himself is cut off. These reptiles are hatched from eggs, which the female deposits in large numbers during the spring in muddy places, where she digs out a spacious cavity, fills it with several hundred eggs, and, thickly covering them with mud, leaves nature to do the rest. After a long incubation the little fellows come out, and make a straight cut for the nearest water. The big alligators who happen to be near make many a toothsome breakfast on the newly-born little ones.

Needlework.

FEMALES.

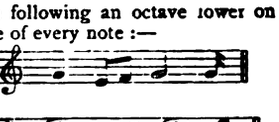
One hour will be allowed for this exercise in the afternoon.

Music.

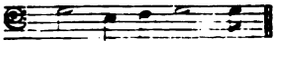
A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

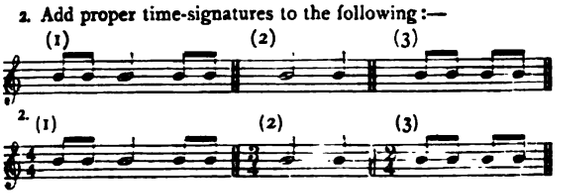
1. Re-write the following an octave lower on the bass clef, doubling the value of every note :—



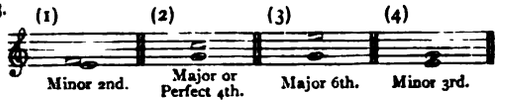
1.



2. Add proper time-signatures to the following:—



3. Write below each of the following intervals its name (major fourth, &c.):—



TONIC SOL-FA NOTATION.

1. Write (1) the signs for three-pulse measure; and (2) the signs for four-pulse measure.

1. (1) | : : ‖ (2) | : | : ‖

2. Write the names of the following intervals:—(1) *me* to *fah*; (2) *soh* to *doh*^{1}; (3) *soh* to *me*^{1}; (4) *me* to *soh*.

2. (1) Minor 2nd; (2) Major or Perfect 4th; (3) Major 6th; (4) Minor 3rd.

3. Write the following an octave lower, and state what is meant by the direction "Key F":—

s m f l s d^1 r f l t d^1

3. s_1 m_1 f_1 l_1 s_1 d r_1 f_1 l_1 t_1 d

By "Key F" is meant that the sound F—the fourth note of the scale of C—is to be called *doh*, and is to be the tonic of the new scale.

SECOND YEAR.

Pupil Teachers at end of Second Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

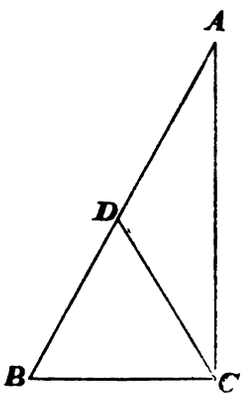
1. The angles at the base of an isosceles triangle are equal to each other; and if the equal sides be produced, the angles on the other side of the base shall be equal.

Euclid, Book I., Prop. 5.

2. If two straight lines cut one another, the vertical or opposite angles shall be equal.

Euclid, Book I., Prop. 15.

3. If a right-angled triangle have one of the acute angles double of the other, the hypotenuse shall be double of the side opposite to the smallest angle.



Let ACB be a right-angled triangle, having the acute ∠ at B double the acute ∠ at A.

Then the side AB is double the side BC.

At the point C make the ∠ ACD = ∠ CAD.

∴ (I. 6) AD = DC.

But ACD is a right ∠ (Hyp.) ∴ CBA, BAC = one right ∠ (I. 32). And ABC is double BAC, and is $\frac{2}{3}$ right ∠, ∴ DCB is $\frac{2}{3}$ right ∠ and = DBC. And (by I. 32) BDC also = $\frac{2}{3}$ right ∠, and the △ DBC is equilateral, ∴ DB = DC or BC. But DA also = DC, *i.e.* BC.

∴ BD, DA are each = BC, *i.e.* BA is double BC.

Arithmetic.

FEMALES.

1. Find the value of $\frac{3}{4}$ of a guinea + $1\frac{3}{8}$ of a crown + $\frac{3}{5}$ of 7s. 6d. − $\frac{3}{4}$ of 2d.

		s.	d.
$\frac{3}{4}$ gui.	$= \frac{3}{4} \times \frac{21}{1} = \frac{63}{4}$s.	= 0	15 9
$1\frac{3}{8}$ cr.	$= \frac{11}{8} \times \frac{5}{1} = \frac{55}{8}$s.	= 0	6 $10\frac{1}{2}$
$\frac{3}{5}$ of 7s 6d.	$= \frac{3}{5} \times \frac{15}{2} = \frac{9}{2}$s.	= 0	4 6
		£1	7 $1\frac{1}{2}$
$\frac{3}{4}$ of 2d.	$= \frac{3}{2}$d.	=	$1\frac{1}{2}$
		£1	7 0 Ans.

2. What weight is the same fraction of 15 cwt. 2 qrs. 13 lbs. that £1 11s. $10\frac{1}{2}$d. is of £3 10s. $1\frac{1}{2}$d.?

$$\frac{\text{£1 11s. } 10\frac{1}{2}\text{d.}}{\text{£3 10s. } 1\frac{1}{2}\text{d.}} = \frac{31\frac{7}{8}\text{s.}}{70\frac{1}{8}\text{s.}} = \frac{255}{561} = \frac{5}{11}$$

$\frac{5}{11}$ of 15 cwt. 2 qrs. 13 lbs.

$= \frac{5}{11}$ of 1749 lbs.

= 795 lbs. or 7 cwt. 11 lbs. Ans.

3. By how much does $3\frac{4}{7} + 9\frac{5}{8} - 5\frac{4}{5}$ fall short of $8\frac{7}{16}$ of $2\frac{7}{19}$?

$$(8\tfrac{7}{16} \text{ of } 2\tfrac{7}{19}) - (3\tfrac{4}{7} + 9\tfrac{5}{8} - 5\tfrac{4}{5})$$

$$= (\tfrac{135}{16} \times \tfrac{45}{19}) - \left(7\frac{180 + 175 - 252}{315}\right)$$

$$= \tfrac{6075}{304} - 7\tfrac{103}{315}$$

$$= 19\tfrac{3875}{9576} - 7\tfrac{103}{315}$$

$$= 12\frac{94185 - 31312}{95760}$$

$$= 12\tfrac{62873}{95760}. \text{ Ans.}$$

4. Convert $\frac{1\frac{1}{16}}{5\frac{4}{7}}$ into a decimal.

$$1\tfrac{1}{16} \div 5\tfrac{4}{7}$$

$$= \tfrac{17}{16} \times \tfrac{7}{39}$$

$$= \tfrac{119}{624}$$

$$= .1875. \text{ Ans.}$$

Grammar.

MALES AND FEMALES.

1. Analyse these lines, showing how many separate sentences they contain, and how each sentence is related to the other.

'The rainbow comes and *goes*,
And *lovely is* the rose;
The moon *doth* with delight
Look round her when the heavens are bare.'

2. Parse the words printed in italics.

1. ANALYSIS.

Sentence.	Kind of Sent.	Connective.	Subject.	Pred.	Object.	Extension.
(1) The rainbow comes	Princ. Sent.		The rainbow	comes		
(2) and goes.	P.S. co-ord. with (1)	and	[it]	goes		
(3) And lovely is the rose;	P.S. co-ord. with (1)	and	the rose	is lovely		
(4) The moon doth with delight look round her	Princ. Sent.		the moon	doth look		round her (*place*) with delight (*manner*)
(5) When the heavens are bare.	Adv. sent. to (4)	when	the heavens	are bare		

2. PARSING.

Goes—irreg. int. verb, act., ind., pres., sing., 3rd, agreeing with *it* understood.
lovely—adj. of quality, qual. *rose.*
is—irreg. intrans. verb, act., ind., pres., 3rd, sing., agreeing with *rose.*
doth—aux. verb to *look*, indicating pres. tense.
look—reg. intrans. verb, inf., pres., gov. by *doth.*
doth look—reg. intrans. verb, act., ind., pres., sing., 3rd, agreeing with *rose.*
round—prep., showing the relation between *her* and *doth look.*
her—per. pro., fem., sing., 3rd, obj., gov. by *round.*
when—advl. conj., joining the two sents.—'The moon doth look' and 'The heavens are bare.'

3. Make sentences in which the predicate shall consist :—
(1) Of the verb to be and a noun.
(2) Of the verb to be and an adjective.
(3) Of the verb to be and a participle.
(4) Of the verb to be and a phrase.

(1) My father *was a farmer.*
(2) Salt *is good.*
(3) Summer *is departing.*
(4) He *is of the greatest use to me.*

4. What is the difference in meaning between the syllable *im* at the beginning of an adjective, and the same syllable at the beginning of a verb? Compare *im*proper and *im*pose; and give other examples.

Im before an adjective means *not;* when used with a verb it means *in, into,* or *upon,* or *to make.*
Improper means *not proper.*
Impose means *to put upon,* or *to place upon.*
Other examples: With adj., impracticable, imprudent, improvident, immature, impartial, impenitent, impossible.
With verb: impair, improve, immerge, immerse, immigrate, imbrue.

Geography.

(*Answer either Q. 2 or Q. 3, not both.*)

1. Define latitude; name some of the towns in Europe in the same latitude with London, and compare the longitude and latitude of Edinburgh and Liverpool.

Latitude is distance north or south from the equator. Places north of the equator are said to be in N. lat.; places south of the equator in S. lat.

Rotterdam, Berlin (nearly), Warsaw, Brest.

Edinburgh is in a higher latitude than Liverpool, being in 55° 57′ N. lat., while Liverpool is in 53° 25′. They are nearly in the same long., Edinburgh being 3° 12′, and Liverpool 2° 59′ W. long.

2. Draw a map of Hindostan.

3. Enumerate the principal British possessions which lie within the tropics, and their chief productions.

The chief British possessions in the tropics are :—

S. India, including Ceylon, producing cotton, coffee, opium, indigo, sugar, jute, pepper, spices, oils, pearls, woods, and fruits.

Western Africa, producing palm oil, gold dust, ivory, teak, ground-nuts, gum, and beeswax.

West Indies, producing sugar, coffee, cocoa, cotton, indigo, arrowroot, ginger, dyewoods, fruits, and maize.

And *Queensland*, producing sugar, cotton, fruits, wool, and hides.

4. Describe the positions of Cadiz, Hamburgh, Antwerp, Odessa, Athens, and Vienna.

Cadiz, on the isle of Leon, in the extreme S.W. of Spain, a few miles N. of Cape Trafalgar. 36° 30′ N. lat., 6° 18′ W. long.

Hamburgh, about 70 miles from the mouth of the river Elbe, 53° 30′ N. lat. 10° E. long.

Antwerp, on the Schelde, in the N. of Belgium, situated in lat. 51° 30′ N., and long. 4° 30′ E.

Odessa, on the Black Sea, in the S. of Russia, between the mouths of the Dnieper and the Dniester, 47° N. lat., and 52° E. long.

Athens, on the Gulf of Egina, in the S. of Greece, about 38° N. lat. and 23° 50′ E. long.

Vienna, in Lower Austria, on the River Danube, 16° 50′ E. long., and 46° 50′ N. lat.

5. Describe in words the courses of the Ganges and the Indus.

The Ganges rises on the northern side of the Himalaya mountains in a large cave. Its course is southward, through transverse valleys in the chain for 200 miles, having in that distance made a descent of nearly 10,000 feet. As it enters the plain of India at Hurdwar it is only some 1,000 feet above the level of the sea. Its course is now S.E. to Allahabad (500 m.), then E. for 500 miles. At the Rajmadal Hills it turns S., and enters the sea by many mouths, forming a large low delta, after a total course of 1,500 miles. It receives the Jumna at Allahabad, and the Sone, which rises in the Vindhya hills, on its right bank, and on its left bank the Goomtee, Gogra, and Gunduck.

The Indus also rises in the Himalayas at a greater height than the Ganges. After a course of 900 miles in a S.W. direction, it reaches the plain of India, and then flows S. for 900 miles more. It receives the Cabul river from Afghanistan on the right, and the Chenab, with Ravee, Jhelum, and Sutlej on the left. These five streams drain the district, called from them the Punjaub.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination paper.

Arithmetic

MALES.

1. Find the simple interest on £750 12s. 6d. from March 10th to August 3rd at 4½ per cent. per annum.

From March 10th to August 3rd is 146 days.

£ £ £ £
100 : 750⅝ :: 4½ : *x* Int.
365 : 146
$= \frac{6000}{8} \times \frac{146}{365} \times \frac{9}{2} \times \frac{1}{100} \times \frac{1}{20}$
$= \underline{£13\ 10s.\ 2{\cdot}7d.}$ Ans.

2. Find the average in the form of a decimal of ·6, ·67, ·659, ·1, and 0; and find the difference between this average and the greatest of the given quantities.

$(\cdot66666 + \cdot67 + \cdot659 + \cdot1 + 0) \div 5.$
$= \underline{\cdot41913}.$ Ans.

Diff. between greatest and average
$= \cdot67 - \cdot41913$
$= \underline{\cdot25086}.$ Ans.

3. If I invest money in 4½ per cent. railway debentures at 134⅞, what interest per cent. shall I get, the broker's charge being 2s. 6d. for each £100 of debentures bought?

Price paid $= 134\frac{7}{8} + \frac{1}{8} = 135.$
Int. on $135 = 4\frac{1}{2}$
,, $1 = \frac{4\frac{1}{2}}{135}$
,, $100 = \frac{4\frac{1}{2} \times 100}{135}$
$= \underline{3\frac{1}{3}}.$ Ans.

4. A dealer by selling a horse for £3 more than he paid for it, gained 6¼ per cent.; what did he pay for the horse?

£
Principal to gain £6¼ = 100
,, ,, 1 = $\frac{100}{6\frac{1}{4}}$
,, ,, £3 = $\frac{100 \times 3}{6\frac{1}{4}}$
$= \underline{£48}.$ Ans

History.

MALES AND FEMALES.

1. The eldest sons of William I., Henry I., Stephen, Henry II., Edward III., Henry VI., and Richard III. did not come to the English throne; tell briefly the fate of those princes.

The eldest son of William I. was Robert. He became Duke of Normandy, joined the Crusades, was taken prisoner by his brother Henry, and after an imprisonment of twenty-seven years died, blind, in Cardiff Castle.

Henry I's. son William was drowned while crossing the Channel from France to England, in 1120.

Stephen's son Eustace on being excluded by treaty from the throne raised a rebellion near St. Edmundsbury, at which place he died in a frenzy when sitting down to a banquet.

The eldest son of Henry II. died in 1156, two years after his father ascended the throne.

The Black Prince, eldest son of Edward III., after taking part in the wars with France, joined Pedro the Cruel, but returned from Spain disabled by sickness, and died in 1376.

Edward, the son of Henry VI., was stabbed by the Dukes of Clarence and Gloucester at Tewkesbury, because he asserted his right to the throne of his father.

Richard III.'s eldest and only son died in 1484.

2. What was Edward III.'s claim to the throne of France? What resulted from the attempts to establish that claim?

Edward III.'s claim to the throne of France was founded on his descent from Philip III.; from whom also the reigning king claimed his descent. Edward's claim was through his mother, daughter of Philip IV. The Salic law, however, precluded females from reigning, and as Philip VI. was the nephew of Philip IV., through his brother Charles of Valois, Edward's claim was untenable.

From Edward's attempts to establish his claim came the wars with France for nearly a century, but in his reign alone there were the battles of Crecy and Poictiers, the siege of Calais, and the defeat and capture of the French king, ending in the peace of Bretigni, in 1360.

3. What occasioned the Wars of the Roses, and how did they end?

The Wars of the Roses were occasioned by the rival claims of the Houses of Lancaster and York to the throne of England. On the deposition of Richard II., grandson of Edward III., the crown went to the descendants of John of Gaunt, Duke of Lancaster, Edward's fourth son, passing over the claims of the descendants of Lionel, the third son. Henry VI.'s incapacity opened the way for a revival of the claims of these descendants, now merged in the family of York, and the prosecution of these claims caused the Wars of the Roses. They ended when Henry VII. was crowned on the battle-field. His marriage with Elizabeth, the heiress of the house of York, still further strengthened his title.

Teaching.

What is meant by *proving* the answer to a sum? Give the rule for proving in subtraction, and show how you would explain and illustrate it to a class.

By proving the answer to a sum is meant the arrival at the same result by another method, or if the process be reversed the obtaining of the numbers with which we started.

To prove a subtraction sum add the less number to the remainder; if this sum equals the larger number, then the subtraction will have been performed correctly.

Example: Take 64 from 81.

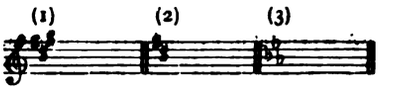
Perform the subtraction on the blackboard, and the remainder will be 17. Now 17 is the number by which 81 exceeds, or is larger than 64. Therefore, 64 and 17 together should equal 81 if the subtraction has been done correctly. Add them together, and the result is 81. The subtraction is, therefore, correct.

Music.

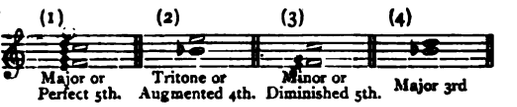
A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

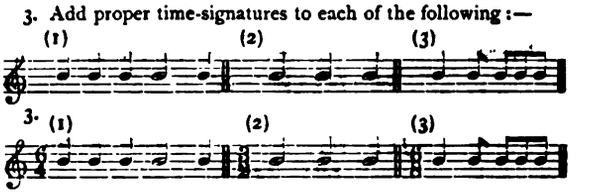
1. Write the key-signatures of each of the following major keys:—(1) of A; (2) of D; (3) of E♭.

1. (1) (2) (3)

2. Write below each of the following intervals its name (major second, &c.):—

2. (1) (2) (3) (4)



3. Add proper time-signatures to each of the following:—



TONIC SOL-FA NOTATION.

1. Write the names of the following intervals:—(1) *lah*, to *me*; (2) *fah* to *te*; (3) *te*, to *fah*; (4) *doh* to *me*.

1. (1) Perfect 5th; (2) Pluperfect 4th or Tritone; (3) Minor or Imperfect 5th; (4) Major 3rd.

2. Which tones of the scale have the strongest leaning tendency?

2. *Fah*, *te*, and *ray*.

3. Write (1) a three-pulse measure; (2) a four-pulse measure; and (3) a six-pulse measure.

3. (1) | : : || (2) | : | : || (3) | : : | : : |

THIRD YEAR.

Pupil Teachers at end of Third Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including No. 3, if you can.

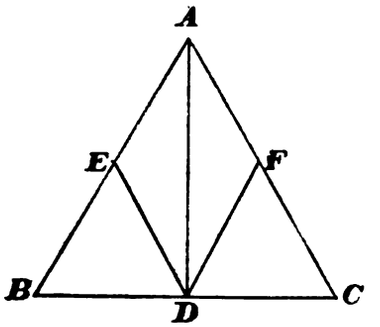
1. The straight lines which join the extremities of two equal and parallel straight lines towards the same parts are also themselves equal and parallel.

Euclid, Book I., Prop. 33.

2. If the square described upon one of the sides of a triangle be equal to the squares described upon the other two sides of it, the angle contained by these two sides is a right angle.

Euclid, Book I., Prop. 48.

3. In the base of a triangle find a point from which lines drawn to each side of the triangle, parallel to the other side, shall be equal.



Let ABC be a △. It is required to find a point in base BC, from which if lines be drawn parallel to the opposite sides they shall be equal to one another.

Bisect ∠ BAC by straight line AD, meeting BC in D. From D draw DF, DE parallel to AB, AC respectively. Join EF.

Then DF = DE.

∵ AF is parallel to ED and AD meets them. ∠ FAD = ∠ EDA. ∵ EA is parallel to FD and AD meets them, ∠ EAD = ∠ ADF.

But ∠ EAD = ∠ FAD (Const.) ∴ Each of the four ∠'s = one another. ∴ (I. 6) EA = ED and AF = FD. And ∵ AE is parallel to DF and AF to ED. ∴ AEDF is a parallelogram, and AE = DF. But AE = ED. ∴ ED = DF.

Wherefore D is the point required.

Q. E. F.

Algebra.

(Answer two Questions, including Question 2, if you can.)

1. Dividend is $6a^3 - 7a^2b + 8ab^2 - 9b^3$, the quotient is $2a - 5b$, and there is a remainder $2b^2(9a + 8b)$. Find the divisor.

$$2b^2(9a+8b) = 18ab^2 + 16b^3$$

$$6a^3 - 7a^2b + 8ab^2 - 9b^3 = 6a^3 - 7a^2b - 10ab^2 - 25b^3$$

$2a - 5b \;)\; 6a^3 - 7a^2b - 10ab^2 - 25b^3 \;(\; 3a^2 + 4ab + 5b^2.$

$6a^3 - 15a^2b$

$8a^2b - 10ab^2$

$8a^2b - 20ab^2$

$10ab^2 - 25b^3$

$10ab^2 - 25b^3$

2. Let A and B represent two expressions, arranged according to descending (or ascending) powers of some common letter, and let B be of not higher dimensions than A. Divide A by B; let p be the quotient, and C the remainder. Divide B by C; let q be the quotient, and let there be no remainder. Prove that C is the greatest common measure of A and B.

Find the G.C.M. of $12m^3x - 9m^2x - 28am^2 + 21an^2$ and $9m^2x - 12n^2x - 21am^2 + 28an^2$.

B) A (p
Bp
C) B (q
Cq

In this ex. A = Bp + C and B = Cq

Because B = Cq, C measures B. It also measures any power of B, ∴ it measures Bp. And it measures itself ∴ it will measure Bp + C. But Bp + C = A. ∴ C measures A.

Now every common measure of A and B will measure A − Bp, that is, C. ∴ Every common measure of A and B is a common measure of B and C. But C is the greatest common measure of B and C, for no higher expression than C can measure C. ∴ C is the highest expression that will measure A and B, that is, their greatest common measure.

$12m^3x - 9m^2x - 28am^2 + 21an^2$
$= 3x(4m^2 - 3n^2) - 7a(4m^2 - 3n^2)$
$= (3x - 7a)(4m^2 - 3n^2)$

And $9m^2x - 12n^2x - 21am^2 + 28an^2$
$= 3x(3m^2 - 4n^2) - 7a(3m^2 - 4n^2)$
$= (3x - 7a)(3m^2 - 4n^2)$

The G.C.M. of
$(3x - 7a)(4m^2 - 3n^2)$ and $(3x - 7a)(3m^2 - 4n^2)$
$= \underline{3x - 7a}$. Ans.

3. Solve the equations :—

(1) $\frac{x}{4} - \frac{x+10}{5} + 4\frac{3}{4} = x - 1 - \frac{x-2}{3}$

(2) $\frac{x-2a}{2b-x} + \frac{x-a}{b-x} = -2.$

(1) $\frac{x}{4} - \frac{x+10}{5} + 4\frac{3}{4} = x - 1 - \frac{x-2}{3}$

$15x - 12x - 120 + 285 = 60x - 60 - 20x + 40 - 37x = -185$

$x = 5$. Ans.

(2) $\frac{x-2a}{2b-x} + \frac{x-a}{b-x} = -2$

$(x-2a)(b-x) + (x-a)(2b-x) = -2(2b-x)(b-x)$

$bx - 2ab - x^2 + 2ax + 2bx - 2ab - x^2 + ax = -4b^2 + 6bx - 2x^2$

$3bx - 2x^2 - 4ab + 3ax = -4b^2 + 6bx - 2x^2$

$3ax - 3bx = 4ab - 4b^2$

$3x(a-b) = 4b(a-b)$

$3x = 4b$

$x = \frac{4b}{3}$. Ans.

Mensuration.

An oblong field is 300 yards long and 200 broad; find the distance from corner to corner. If a belt of trees, 30 yards wide, be planted round it, find the area of the interior space.

$\sqrt{300^2 + 200^2} = \sqrt{90000 + 40000}$
$= \sqrt{130000} = \underline{360{\cdot}55}$ + yds. Ans.

(300 − 60) (200 − 60) yds.
= 240 × 140
= 33600 sq. yds.
= 6 acres 4560 yds. Ans.

Arithmetic.

FEMALES.

1. Prove that $2{\cdot}4\dot{5}$ multiplied by $3{\cdot}1\dot{6} \div {\cdot}012\dot{6}$ is equal to $615{\cdot}\dot{6}$.

$2{\cdot}4\dot{5} \times 3{\cdot}1\dot{6} \div {\cdot}012\dot{6} = 615{\cdot}\dot{6}$
$= 2\frac{45}{99} \times 3\frac{16}{99} \div \frac{126}{9900} = 615\frac{2}{3}$
$= \frac{247}{99} \times \frac{19}{6} \times \frac{2926}{5} = \frac{8978}{5}$
$= \frac{8973}{5} = 3\frac{978}{5}$. Ans.

2. Divide 21·3962 by ·527, and 213962 by ·000527.

·527) 21·3962 (40·6. Ans.
21 08
3162
3162

·000527) 213962·000000 (406,000,000. Ans.
2108
3162
3162
000000

3. A bankrupt can pay 6s. 8d. in the £; if his assets were £500 more he could pay 7s. 4d. Find his debts and his assets.

7s. 4d. − 6s. 8d. = 8d.
£500 represents 8d. in the £
£ £
As 8 : 240 :: 500 : x Debts
= £15,000. Ans.
d. d. £ £
As 240 : 80 :: 15000 : x Assets
= £5000. Ans.

4. Find the value of ·65 of £4 10s. 0d. + ·0125 of £5 13s. 4d.

·65 of 90s. = 58·50s. = ...	£2 18 6
·0125 of £5 13s. 4d. = $\frac{1}{80}$ of £5 13s. 4d. =	0 1 5
	£2 19 11. Ans.

Grammar.

MALES AND FEMALES.

1. Analyse fully the following passage :—

I would not have a slave to till my ground,
To carry me, to fan me while I sleep
And tremble when I wake, for all the wealth
That sinews bought and sold have ever earned.

ANALYSIS.

Sentence.	Kind of Sent.	Connective.	Subject.	Predicate.	Object.	Ext. of Pred.
(a) I would not have a slave to till my ground for all the wealth	P.S.		I	would have	a slave	not (neg.) to till my ground for all the wealth (reason)
(b) To carry me,	P.S. contracted co-ord. with (a)		[I]	[would have]	[a slave]	[not] to carry me (reason)
(c) To fan me	Do.		[I]	[would have]	[a slave]	[not] to fan me (reason)
(d) While I sleep,	Adv. s. to (d)	while	I	sleep		
(e) And tremble	As (b)	and	[I]	[would have]	[a slave]	[not] to tremble (reason)
(f) When I wake,	Adv. s. to (e)	when	I	wake		
(g) That sinews bought and sold have ever earned.	Adj. to *wealth* in (a)	*Inrel*	sinews bought and sold	have earned	that	ever (time)

2. Give examples in sentences of your own :—

(1) Of a passive verb.
(2) Of the subjunctive mood.
(3) Of an adverbial phrase.
(4) Of an adverbial sentence.

(1) Julius Cæsar *was murdered* by the conspirators.
(2) If he *be* a traitor, he will certainly betray us.
(3) The children were playing *very happily on the common.*
(4) I laid it *where it could easily be seen.*

3. Write out the first eight lines of the poetry which you have learned by heart this year; and then write the substance of it in your own words.

4. Explain the significance of the final syllable in each of the following words; say to what language the words belong, and give two other examples of the same formation in each case: christian*ize*, glori*fy*, black*ish*, reduc*tion*, shepherd*ess*, graci*ous*, merci*ful*.

-ize = to do or to make; Greek.—baptize, moralize.
-fy = to do or to make; Latin,—magnify, satisfy.
-ish = a little or somewhat; Saxon,—whitish, brownish.
-tion = action; Latin,—action, election.
-ess = female agent; Latin,—governess, sorceress.
-ious = full of; Latin,—glorious, envious.
-ful = full of; Saxon,—thankful, sinful.

Geography.

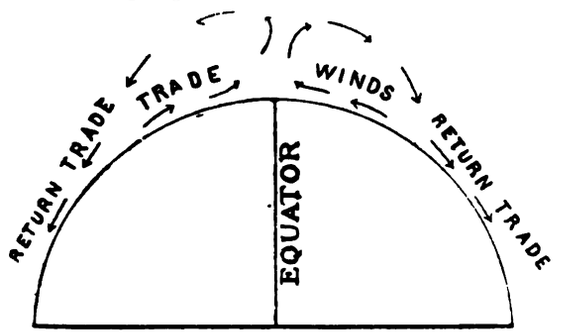
(*Answer Q.* 1, *and either Q.* 2, *or Q.* 3.)

1. Draw a map of Africa.

2. Give the causes of the trade winds, and illustrate by a diagram.

The heat at the equator is so great that the air becomes rarefied and ascends. The colder air from the north and south of the equator rushes in to fill the place of that which has become rare and aseended, blowing from north and south. The motion of the earth at the equator is however faster than the land at a distance. The north and south winds are as it were thus left behind and become N.E. and S.E. winds. As the heated air which has ascended flows off towards the poles it becomes cooler and nears the surface of the earth again in latitudes 40° to 50° N. and S. These winds are known as the return trade winds.

The following diagram illustrates the text:



3. Give a full account of the Himalayas, of the plateau of Thibet, and of the desert of Gobi.

The Himalaya range (1500 miles long) is the highest in the world. It runs from east to west, and the average height of the peaks is 20,000 feet. Mt. Everest (29,000 feet) is the highest peak. Other peaks are Kunchinjinga and Dhawalagira. The range has a width of from 200 to 400 miles. The longest slope is towards the north. Its peaks are covered with perpetual snow, and the range is the source of the Ganges, Indus, Brahmapootra, and other rivers.

Thibet is the loftiest plateau in the world, in no place being less than 12,000 feet above the level of the sea. It lies immediately to the north of the Himalayas, and is bounded on the north by the Kuen Luen Mts., on the west by the continuation of the Himalayas, and east by China. Its climate is dry in summer, and cold in winter.

The desert of Gobi lies between the Kuen Luen Mts. on the south, and the Altai Mts. on the north. It occupies nearly all Mongolia, and is 1500 miles long by 1100 miles broad. It is a rainless region, and has immense tracks of sand and salt. It is called Shamo by the Chinese.

4. Describe the region of the Nile and give a brief account of the Soudan.

The Nile, the river of Egypt, flows from the centre of Africa in a northerly direction to the Mediterranean Sea. Its chief branch, the Bahr-el-Abiad, or White Nile, rises in Lake Nyanza. At Khartoum in Nubia it is joined by the Bahr-el-Azrek, or Blue Nile, from Abyssinia. Descending several cataracts it enters Egypt by a valley somewhat contracted. At Cairo the valley widens, and the river separates into two great arms, forming a fruitful delta, at the eastern extremity of which stands Damietta, and at the western Rosetta. The length of the river is probably 3000 miles.

Soudan is the name given to the district of Central Africa south of the Sahara, and comprises the regions watered by the Niger, the district around Lake Tchad, and the Egyptian possessions of S. Nubia, Darfur, Kordofan, and the valley of the Nile to the equator. Its inhabitants are chiefly negroes, who have been conquered by Arab tribes, and these in turn by the Egyptians. A general rising of the Arabs, under the Mahdi, is now in progress. Many of the Egyptian garrisons have been massacred.

5. Describe briefly the Chinese Empire.

The Chinese Empire lies to the east of Asia. It is bounded on the N. by Siberia, on the W. by Siberia and Turkestan, on the S. by India and Burmah, and on the E. by the Pacific. It includes China Proper, Thibet, Mongolia, and Manchooria. It contains 4½ million sq. miles, and has a population of probably 435 millions. Its rivers are Hoang-ho, Yang-tse-kiang, Peiho, and Canton; its towns Pekin, Nankin, Canton, Shanghai, Foochow, and many others. It is governed by an emperor, its people are industrious and skilful. For thousands of years the arts of civilisation have been known amongst them, but they are very exclusive, and dislike foreigners.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. What is meant by banker's discount? If a merchant takes a bill of £550 to be discounted, and the banker gives him £533 10s. for it, what percentage has the banker charged?

Banker's discount is the money he deducts for paying a bill before due, and is equal to the interest which would be made by the sum named in the bill from the time when discounted to the time when due, at the given rate per cent.

Deduction = £550 − £533 10s. = £16 10s.

Deduction per cent. =

£ s. £
As 550 : 100 :: 16 10 : x = £3 per cent. Ans.

2. What numbers multiplied by themselves will produce 398·0025 and 32·1 respectively?

398·0025(19·95. Ans.
1
29)298
261
389)3700
3501
3985)19925
19925
.....

32·1 = 32⅒ = ³²⁰⁄₁₀
√²⁵⁶⁄₁₀ = ¹⁶⁄₅ = 5⅘
= 5·6. Ans.

3. A man left £25,750 to be divided amongst his children in the proportion of ½ to his eldest son, ¼ to each of his second and third sons, and ⅛ to his daughter. Find the shares of each.

½, ¼, ¼, ⅛ = 40, 24, 24, 15.
Total parts = 103.

$\frac{10}{16}$ of £25,750 = £10,000 to eldest son.

$\frac{3}{16}$,, ,, = £6000 to 2nd and 3rd sons.

$\frac{3}{16}$,, ,, = £3750 to daughter.

4. If a man walks 168 miles in 4 days, and he walks 3 miles each day (after the first) more than on the preceding day, how many miles did he walk the first day?

On the second day he walked 3 miles more than the first.
,, third ,, ,, 3+3=6 ,, ,,
,, fourth ,, ,, 6+3=9 ,, ,,
Total distance walked above the common distance
=3+6+9=18.

Distance on first day $= \frac{168-18}{4} = 37\frac{1}{2}$ miles. Ans.

History.

MALES AND FEMALES.

1. The eldest sons of Henry VII., James II., Queen Anne, and George II., did not come to the throne. What can you tell about those princes?

Arthur was the eldest son of Henry VII., and died in 1502 while quite young. He left a widow, Catherine of Arragon, who afterwards became the first wife of his brother, Henry VIII.

James II. was deposed while his son was an infant. During the reign of Anne there were many intrigues to secure the succession to his son, under the title of James III. They were unsuccessful. He tried, personally, to obtain the throne in 1715, but was unsuccessful. He died at St. Germains in 1765.

Queen Anne's children all died in infancy. William, the eldest, was a youth of considerable promise, but died in his twelfth year, in 1700.

The eldest son of George II. was Frederick, Prince of Wales. He frequently quarrelled with his father owing to his ungovernable temper, and died unregretted in 1751. His son became George III.

2. What do you know about the wife and mother of William III.?

The mother of William III. was the eldest daughter of Charles I., who married Prince William of Nassau. William's wife was his cousin, the eldest daughter of James II. She was crowned queen and reigned along with William III. from the Revolution in 1689 to her death in 1694, under the title of Mary II. She died of small-pox.

3. Where and when was the battle of Waterloo fought? What nations were engaged in it, and with what result?

The battle of Waterloo was fought on Sunday, June 18th, 1815, at Waterloo, a place about nine miles from Brussels, the capital of Belgium.

The combatants were the French under Napoleon Bonaparte, Emperor, and the allied armies of England, Belgium, Holland, and Hanover, under Wellington. The Prussians under Blucher arrived when the battle was nearly over, and joined in the pursuit of the French. The French were totally defeated, 30,000 being killed, Napoleon fled, abdicated, and was taken prisoner, dying in St. Helena. Peace followed, and lasted nearly forty years.

Teaching.

Show how and with what illustrations you would give a first lesson to young children on *one* of these subjects:—

Silver coins.
A pronoun.
A waterfall.

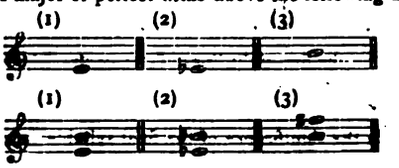
Silver Coins.—Talk about what the children like, how they get things they like, and when they cannot get them at home, how they can be had at a shop. Proceed to speak of buying with money, and ask the names of pieces they had seen, showing half-penny and penny. These made of bronze. A brighter and more valuable metal called silver. Silver more scarce than copper, therefore a little of it will equal a much larger piece of copper. Compare a penny and a shilling, as to colour, appearance, weight, and value. The latter worth twelve of the former. Show other coins, threepenny, fourpenny, and sixpenny pieces, florin, half-crown, and crown. State their values, and give numerous exercises in expressing one in terms of the other, thus—a shilling=2 sixpences, 3 fourpences=4 threepences, and is half a florin, etc. Show that all bear the effigy of the Queen, and other marks.

Music.

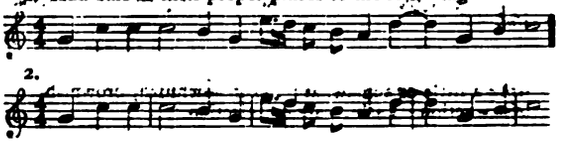
A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write major or perfect fifths above the following notes:—



2. Add bars in their proper places to the following:—



3. State (briefly) the meanings of the following:—(1) *Pianissimo*; (2) *a tempo*; (3) *Adagio*.

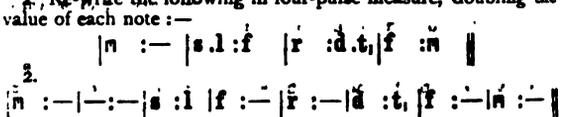
3. (1) Very soft; (2) in time; (3) very slow.

TONIC SOL-FA NOTATION.

1. Write major or perfect fifths above the following notes:—(1) *soh*; (2) *doh*; (3) *te*,.

1. (1) *soh, ray*^{1}; (2) *doh, soh*; (3) *te*,, *fe*.

2. Re-write the following in four-pulse measure, doubling the value of each note:—



3. State (briefly) the meanings of the following:—(1) *Pianissimo*; (2) *a tempo*; (3) *Adagio*.

3. (1) Very soft; (2) in time; (3) very slow.

FOURTH YEAR.

Pupil Teachers at end of Fourth Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* are admissible.]

Answer two Questions, including No. 3, if you can.

1. If two angles of a triangle be equal to each other, the sides also which subtend, or are opposite to, the equal angles, shall be equal to one another.

Euclid, Bk. I., Prop. 6.

2. If a straight line be divided into any two parts, the square on the whole line is equal to the squares on the two parts, together with twice the rectangle contained by the parts.

Euclid, Bk. II., Prop. 4.

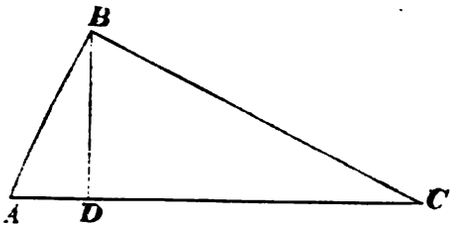
3. If the square on the perpendicular from the vertex of a triangle on the base is equal to the rectangle contained by the segments of the base, the vertical angle is a right angle.

Let ABC be a $\triangle$, and AD a perpendicular let fall from the vertical $\angle$ to the base so that the sq. on AD = the rectangle contained by BD, DC.

Then $\angle$ BAC is a right $\angle$.

The sq. on AB=sqs. on BD, DA, and sq. on AC=sqs. on CD, DA (I. 47) $\therefore$ sqs. on BA, AC=sqs. on BD, DC+2 sq.

on AD. And sq. on BC = sqs. on BD, DC + 2 rectangle BD,



DC (II. 4). But sq. on AD = rectangle BD, DC (Hyp.) ∴ 2 sq. on AD = 2 rect. BD, DC. ∴ sq. on. BC = sqs. on BA, AC. ∴ ∠ BAC is a right ∠ (I. 48).

Q. E. D.

Algebra.

Answer two Questions, including No. 2, if you can.

1. If $\frac{a}{b}=\frac{c}{d}$ show that $\frac{a+b}{a-b}=\frac{c+d}{c-d}$, and that $\frac{a}{b}=\frac{ma+nc}{mb+nd}$

(a) $\frac{a+b}{a-b}=\frac{c+d}{c-d}$

Let $\frac{a}{b}=x$, then $a=bx$ and $c=dx$

Substituting the value of a

$$\frac{a+b}{a-b}=\frac{bx+b}{bx-b}=\frac{b(x+1)}{b(x-1)}=\frac{x+1}{x-1}$$

Also $$\frac{c+d}{c-d}=\frac{dx+d}{dx-d}=\frac{d(x+1)}{d(x-1)}=\frac{x+1}{x-1}$$

Since $\frac{a+b}{a-b}$ and $\frac{c+d}{c-d}$ each $=\frac{x+1}{x-1}$

$$\therefore \underline{\frac{a+b}{a-b}=\frac{c+d}{c-d}}$$

(b) $$\frac{a}{b}=\frac{ma+nc}{mb+nd}$$

As before let $\frac{a}{b}=x$ ∴ $a=bx$ and $c=dx$

And $a+c=bx+dx$ or $x(b+d)$

$$\therefore\ x=\frac{a+c}{b+d}$$

But $ma=mbx$ ∵ $a=bx$

And $nc=ndx$ ∵ $c=dx$

$$\therefore\ ma+nc=mbx+ndx$$
$$=(mb+nd)x$$
$$\therefore\ x=\frac{ma+nc}{mb+nd}$$

But $x=\frac{a}{b}$ ∴ $\underline{\frac{a}{b}=\frac{ma+nc}{mb+nd}}$

2. Explain, as to a boy beginning quadratic equations, the general rule of solving a simple form, *e.g.*, $x^2+px+q=0$.

Solve :— (1) $x^2-x-342=0$.

(2) $\frac{x^2}{a^2}-\frac{a^2}{b^2}=\frac{a^2}{b^2}-\frac{x}{b}$.

Rule.— Place the quantities containing x, or any power of x, on the left, and the remaining quantities on the right of the sign of equality (thus, $x^2+px=q$). Add to each side half the coefficient of x squared, thus $\left(\frac{p}{2}\right)^2$. Then extract the square root of each side, and the value of x will be obtained as in simple equations.

Adding half the coeff. of x completes the square. In the general results in mult. it will be seen that the square of a binomial is the sum of the sqs. of the terms + or − twice their product. If we know the sq. of the first term, and the coefficient of x in the second term of the sq., the third term of the sq. is, as stated, half the coefficient squared. If added to one side the equation it must also be added to the other.

As *like signs* give + in the product, the square root of the right-hand term will be + or − according to the terms of the question.

(1) $$x^2-x-342=0$$
$$x^2-x=342$$
$$x^2-x+(\tfrac{1}{2})^2=342+(\tfrac{1}{2})^2$$
$$x-\tfrac{1}{2}=\pm\tfrac{37}{2}$$
$$\underline{x=+19 \text{ or } -18.}\quad \text{Ans.}$$

(2) $$\frac{x^2}{a^2}-\frac{a^2}{b^2}=\frac{a^2}{b^2}-\frac{x}{b}$$
$$b^2x^2-a^4=a^4-a^2bx$$
$$b^2x^2+a^2bx=2a^4$$
$$x^2+\frac{a^2}{b}x=\frac{2a^4}{b^2}$$
$$x^2+\frac{a^2}{b}x+\left(\frac{a^2}{2b}\right)^2=\frac{2a^4}{b^2}+\left(\frac{a^2}{2b}\right)^2$$
$$x+\frac{a^2}{2b}=\pm\frac{3a^2}{2b}$$
$$\underline{x=\frac{a^2}{b} \text{ or } -\frac{2a^2}{b}}\quad \text{Ans.}$$

3. Two lame men had a race which lasted 5 minutes; one had a start of 20 yards, but the other went half as fast again and won by 30 yards. Find the length of the course.

Let x = length of course in yds.

$\frac{x}{5}$ = No. yds. run per min. by faster runner.

$\frac{x-20}{5}-\frac{30}{5}$ = " " " " slower "

The speed of the slower runner is $\frac{2}{3}$ that of the faster runner.

$$\therefore\ \tfrac{2}{3}\left(\frac{x}{5}\right)=\frac{x-50}{5}$$
$$\frac{2x}{15}=\frac{x-50}{5}$$
$$2x=3x-150$$
$$\underline{x=150 \text{ yds.}}\quad \text{Ans.}$$

Mensuration.

If a pressure of 15 lbs. on every square inch be applied to a circular plate 3 feet in diameter, find the total pressure to the nearest hundredweight.

Pressure in lbs. $=(\frac{1}{2}\text{ dia.})^2\times 3\frac{1}{7}\times 15$

$$\therefore \text{ Total pressure in cwts.}=\frac{18\times 18\times 22\times 15}{7\times 112}$$
$$=\underline{136\tfrac{17}{56}\text{ cwt.}}\quad \text{Ans.}$$

Arithmetic.

FEMALES.

1. Find the principal which, in $4\frac{1}{2}$ years at $4\frac{1}{2}$ per cent., will amount to £962.

Int. on £100 $=4\frac{1}{2}\times 4\frac{1}{2}=20\frac{1}{2}$.

In $4\frac{1}{2}$ yrs. £100 becomes £$120\frac{1}{2}$.

$$\therefore \text{ As } 120\tfrac{1}{2} : 962 :: 100 : x$$
$$=\underline{£800.}\quad \text{Ans.}$$

2. *A* and *B* together can do a piece of work in 30 days, *B* by himself can perform the same in 70 days. In what time could *A* do it alone?

A and *B* do $\frac{1}{30}$ in a day.

B does $\frac{1}{70}$ "

A does $\frac{1}{30}-\frac{1}{70}=\frac{4}{210}$ "

∴ *A* will take $\frac{210}{4}=\underline{52\frac{1}{2}\text{ days.}}$ Ans.

3. At what times between 6 and 7 are the hands of a clock at right angles?

The minute hand can be twice at right angles to the hour hand during the hour, viz., when it is 15 mins. before the hour hand, and when 45 mins. before it.

As the min. hand travels 60 mins., while the hour hand travels 5 mins. it gains 55 mins. in the hour.

∴ Time when at right angles =

m. m. m. m.

$$\therefore\ 55 : 15 :: 60 : x$$
$$=\underline{16\tfrac{4}{11}\text{ mins. past 6.}}$$
$$\text{and } \therefore\ 55 : 45 :: 60 : x$$
$$=\underline{49\tfrac{1}{11}\quad "\quad "}$$

} Ans.

4. A person in his will directed that $\frac{1}{2}$ his property should be given to A, $\frac{1}{3}$ to B, $\frac{1}{4}$ to C, and $\frac{1}{5}$ to D; show that this disposition cannot be carried out. If his property amounted to £471 12s. 6d., dispose of it so that their shares may have to one another the relation he intended.

$\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}=\frac{37}{30}$ which is more than 1, the whole property.

Divide the property into 77 parts, giving them 30, 20, 15, and 12.

	£	s.	d.	£	s.	d.	
30/77 of	471	12	6	= 183	15	0	Ans.
20/77 ,,	,,			= 122	10	0	
15/77 ,,	,,			= 91	17	6	
12/77 ,,	,,			= 73	10	0	
Proof	471	12	6				

Grammar.

MALES AND FEMALES.

Ethereal minstrel, pilgrim of the sky,
Dost thou despise the earth where cares abound?
Or while the wings aspire, are heart and eye
Both with thy nest upon the dewy ground?
Thy nest which thou canst drop into at will,
Those quivering wings composed, that music still.

Leave to the nightingale her shady wood,
A privacy of glorious light is thine,
Whence thou dost pour upon the world a flood
Of harmony, with instinct more divine;
Type of the wise, who soar but never roam,
True to the kindred points of heav'n and home.

WORDSWORTH, *Ode to a Skylark.*

(*a*) Paraphrase these verses.

(*b*) Analyse the first four lines of the second stanza.

(*c*) Select from the passage any word which you know to be of Latin origin. Give its root, and mention any other words similarly derived.

(*d*) Say whether there is any one of the rhymes less perfect than the rest, and give a reason for your answer.

(*a*) Heavenly songster! wanderer through the sky! dost thou fly to the heavens because thou art scornful of earth and its cares? Or while thou art so high on wing, are both thy sight and thought on the spot where thy nest is placed, and into which thou canst at pleasure fall, thy singing hushed and thy beating wings at rest?

The shady covert of the wood may be left to the bird of night; thy privacy is just as great although thou art surrounded by the blaze of day, and from thy lonely height thou dost more truly bless the world with thy wealth of song. In this thou art a fit emblem of the wise and good, who rise above their fellow-men, but are ever loyal to the twin-like places, heaven and home.

(*b*) ANALYSIS.

Sentence.	Kind of Sentence.	Connective.	Subject.	Predicate.	Object.	Extension.
(*a*) Leave to the nightingale her shady grove	Princ. sent.		[thou]	leave	her shady grove to the nightingale	
(*b*) A privacy of glorious light is thine	Princ. sent.		thine	is a privacy of glorious light		
(*c*) Whence thou dost pour upon the world a flood of harmony with instinct more divine.	Adj. sent. to (*b*)	whence	thou with instinct more divine	dost pour	a flood of harmony	upon the world (place)

(*c*) *Aspire:* from *a* or *ad*, to, and *spira*, to breathe.
Other words from same root: inspire, conspire, respire.

(*d*) The least perfect rhyme is that of *sky* and *eye*.
The identity of the vowel sounds is the same, but the consonant sound of the latter part of the rhyme, although different, does not form part of the one syllable with the vowel sound as in the first part of the rhyme.

2. Say when Shakespeare, Milton, and Wordsworth lived, and what they wrote.

Shakespeare (1564-1616) wrote plays, sonnets, and minor poems. His plays were tragedies, comedies, and historical plays; *e.g.*, 'Hamlet,' 'Midsummer Night's Dream,' 'Julius Cæsar.'

Milton (1608-1674) wrote poems ('Paradise Lost and Regained,' 'Comus,' 'Samson Agonistes'), and many political pamphlets, chiefly in defence of the Commonwealth.

Wordsworth (1770-1850) wrote poems, descriptive sketches, lyrical ballads, sonnets, 'The Excursion' and 'The Prelude.'

Geography.

(*Answer two Questions.*)

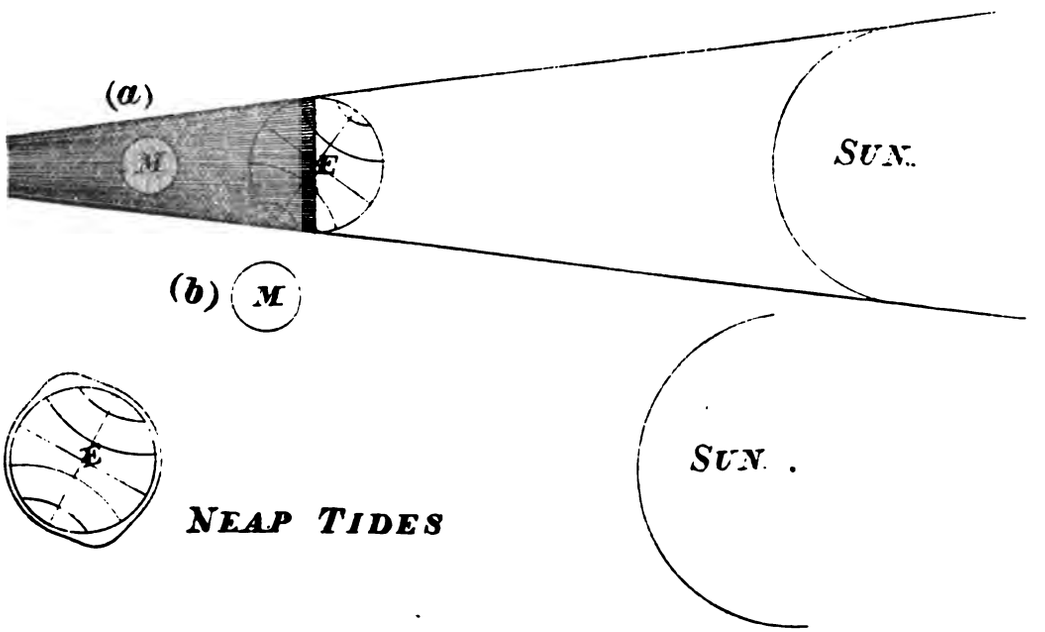
1. Draw a map of South America.

2. Enumerate the five planets nearest to the earth, and account for the occasional apparently retrograde motion of the superior planets.

Mercury, Venus, Mars, Jupiter, Saturn.

The apparently retrograde motion of the superior planets is due to their own motion and that of the earth round the sun. Venus and Mercury revolve round the sun in 225 and 88 days respectively. The whole of their orbits is within the earth's orbit. Part of their motion for a certain distance will therefore be from W. to E. When at certain angles on opposite sides they will appear stationary, and then the motion will be from E. to W. when they are between the earth and the sun. This apparent motion from E. to W. is their retrograde motion.

3. Make diagrams illustrating an eclipse of the moon, and neap tides: and show why an eclipse of the moon does not take place every month.



NEAP TIDES

An eclipse of the moon does not take place every month because the plane of the earth's orbit and the plane of the moon's orbit are not identical. The light of the sun can thus reach the moon even when the earth appears to be between the moon and the sun; the sun shining as it were on the moon over or under the earth.

4. Describe a journey to India, viâ Vienna and the Suez Canal.

London being left behind we proceed to the Continent from Harwich, on the Essex coast. Crossing the North Sea we arrive at Flushing, and proceed by Coblentz, Carlsruhe, Munich, to Vienna on the Danube. This is the capital of Austria, and is a large city of 1,000,000 inhabitants, and the chief manufacturing town of the empire. From Vienna we may take the route southwards to Trieste, the chief port of Austria, on the Adriatic, or pass through Italy, calling at Florence, Rome, and Naples, to Brindisi. Sailing from Trieste down the Adriatic through the Straits of Otranto, we proceed S.E. to the entrance to the Suez Canal at Port Said. The Canal is 75 miles long and passes through the Bitter Lakes, joining the Red Sea by its westernmost arm at Suez, Ismailia being passed on the way. On the Red Sea, we are troubled with the intense heat. Suakim lies on the W., midway down the sea. At Aden, near the entrance, we get coal, and sail in a N.E. direction across the Arabian Sea, to Bombay, the largest port on the W. coast of India.

5. Enumerate the chief productions of Jamaica, Newfoundland, Japan, and Ceylon.

Jamaica.—Sugar, rum, coffee, allspice, pimento, logwood, arrowroot, and ginger, fruits in abundance, including cocoa-nuts, breadfruit, oranges, mangoes, and pears.

Newfoundland.—Fish (especially cod), seal-oil, cod-oil, train-oil, dried fish, tinned fish (salmon, lobster, and crab).

Japan.—For export little; rice, tea, cotton, camphor trees are cultivated, silk, cotton, porcelain, lacquered work exported.

Ceylon.—Coffee, cocoa-nuts, cocoa-nut oil, linseed-oil, spices, pearls, fancy woods, rice, cinnamon, hemp, linseed.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. If a grocer gains 5 per cent. by selling tea at 2s. 6d. a lb., what per cent. would he gain by selling it at 2s. 8d. a lb.?

By selling at 2s. 6d. £100 becomes £105

s. d.	s. d.	£	£
∴ 2 6	: 2 8	:: 105	: x

$= 112$

£112 − £100 = 12 per cent. gain. Ans.

2. Find the exact value, or the approximate value to 3 decimal places of $\frac{\sqrt{\cdot9}+\sqrt{\cdot4}}{\sqrt{\cdot9}-\sqrt{\cdot4}}$

$$\frac{\sqrt{\cdot9}+\sqrt{\cdot4}}{\sqrt{\cdot9}-\sqrt{\cdot4}} = \frac{\cdot9486+\cdot6324}{\cdot9486-\cdot6324}$$

$$= \frac{1\cdot5810}{\cdot3162} = 5. \quad \text{Ans.}$$

3. An army of 20,000 men had rations for 30 days, but after 6 days 5000 men were sent away, and after 8 days more 3000 were sent away. How long beyond the 30 days did the rations last?

The amount of food left when 5000 are sent away will support 20,000 for 24 days. It will therefore support 15,000 for

		days	days
15,000	: 20,000	:: 24	: x

$= 32$ days.

These live upon it for 8 days and the remainder would therefore serve them 24 days, or would serve (15,000 − 3000) = 12,000 men for

		days	days
12,000	: 15,000	:: 24	: x

$= 30$ days.

Total time beyond 30 days = (6 + 8 + 30) − 30 = 14 days. Ans.

4. A invests a sum of money in 3 per cents. at par, and B an equal sum in 5 per cent. railway stock. If A's and B's dividends are as 7 to 8, find the price of the railway stock, brokerage being omitted.

If 3 per cent. produces 7 for A, then 8 is produced for B by

As 7 : 8 :: 3 : x

$= 3\frac{3}{7}$ per cent.

If B gets $3\frac{3}{7}$ per cent. for his money, the price of the railway stock is

		£	£
As $3\frac{3}{7}$	: 5	:: 100	: x

$= 145\frac{5}{8}$. Ans,

History.

MALES AND FEMALES.

1. Among the early English people what rights depended upon the holding of land?

In the time of the Saxons the possession of at least five hides of land entitled the holder to the rank of thane.

The possession of great quantities of land gave the holders the right of having their word counted as against that of six or twelve cæorls in courts of justice.

The thanes and ealdormen formed the principal part of the Witan.

To them belonged the right of appointing a new king. They were also the advisers of the king, and the judges in courts of justice.

2. How did James II. lose the throne? Why in the settlement of the Crown were descendants of Charles I. passed over?

James II. wished to re-establish the Roman Catholic religion in the country, and to open the public offices and Parliament to his co-religionists. He thus alienated the loyalty of his people by selecting Roman Catholic privy councillors, appointing a R. C. governor of Ireland, reviving the Court of High Commission, appointing R. C. president of Magdalen College and Dean of Christchurch, by issuing a *Declaration of Indulgence*, and ordering it to be read in the churches, by trying the seven bishops for refusing to obey the order and petitioning against it, and by generally acting in opposition to the laws of the country.

Because it was deemed inconsistent with the safety and welfare of the kingdom to be governed by Popish princes.

3. What were the 'six points' demanded by the Chartists? Describe the attempt to enforce their demand, and say how far it has now been conceded.

The six points of the People's Charter were:—Universal suffrage (excluding women), equal electoral districts, vote by ballot, annual parliaments, no property qualification for members, and payment of members.

The Chartists mustered in large numbers on Kennington Common, April 10th, 1848, marched through London to the House of Commons to present a monster petition embodying their claims. The affair passed off quietly without the need of troops, which were in readiness, under the Duke of Wellington. Several of the ringleaders were imprisoned, but the Chartists from that time ceased to be of importance as an organised body.

Since 1848 the property qualification has been abolished, vote by ballot adopted, and household suffrage is in existence in boroughs, and will probably be extended to the counties in a short time.

4. Describe the principal extensions of territory made by the English since the beginning of this century.

The following is a list of the extensions of the British empire during the nineteenth century:—

India—a very large portion annexed, including Assam, Aracan, Tenasserim, Sinde, Punjab, Nagpore, Oude.

Western Australia, South Australia, Tasmania, New Zealand, Victoria, colonised and made into separate districts.

Natal, British Kaffraria, settled, and Guiana and Cape Colony taken from the Dutch.

British Columbia made a colony, and nearly the whole of the colonies in N. America united in one dominion of Canada.

Fiji and Ascension annexed; Cyprus in the Mediterranean, and islands in the W. Indies and other places taken or ceded. Extensions of territory in Asia, Africa, and Oceania are still taking place.

Teaching.

Sketch out the notes of a lesson on one of these subjects :—

Glaciers.
Decimal fractions.
A tan-yard.

Formation of glaciers.—Speak of snow line, and district near it. Partial melting of snow and freezing again during winter. Repeated falls of snow, and constant accumulation. Plateaus at or near or above the snow-line most favourable places for their formation.

Movements of glaciers.—Great weight of accumulated snow pushes glacier forward towards the lowest level, valleys thus gradually filled with them. Movements rapid or slow often according to the heat of summer and cold of winter. Rate from a few inches to several hundreds of feet in a year.

Action of glaciers.—Grinding action on the sides of the valleys, rocks smoothed, *debris* carried down and deposited along the sides of valleys, (*moraines*), great stones often carried considerable distances.

Danger of crossing glaciers.—Ice often cracks, great crevices formed, (*crevasses*), these sometimes covered with snow, prove traps for unwary travellers.

Famous glaciers.—In Norway, Jostedal and Folge Fonde. In Switzerland, Rhine and Rhone glacier, etc.

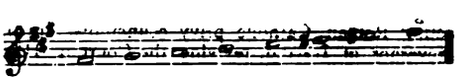
Music.

A quarter of an hour allowed for this paper.

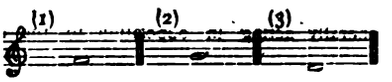
(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write in the treble clef the signature and the ascending scale of F♯ minor, using the major or sharp sixth and the sharp seventh.

1.



2. Write an augmented fifth above each of the following notes :—



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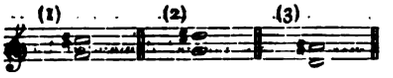
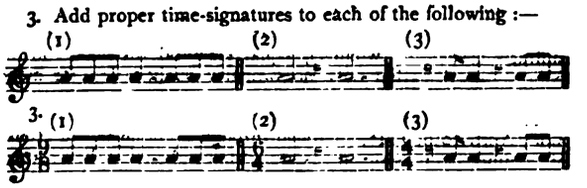


3. Add proper time-signatures to each of the following :—



TONIC SOL-FA NOTATION.

1. Write an augmented fifth above each of the following notes :—(1) *fah* ; (2) *soh* ; (3) *ray*.

1. (1) *fah, de'* ; (2) *soh, re'* ; (3) *ray, le.*

2. Write the minor scale (*lah* mode), using the minor or flat sixth and the major or sharp seventh.

2. l, t, d r m f se l

3. Write the following in six-pulse measure by trebling the value of every note :—

|s ,l ,s :f |f ,- ,s :m ‖

3. |s :l :s |f :- :- |f :- :s |m :- :- ‖

Matriculation Hints.

BY HENRY A. REATCHLOUS, M.A. (LOND.), B.Sc.,

Westminster Training College.

THE following are translations of the passages set at the recent matriculation examination of the London University (see page 237) :—

LATIN.

1. 'Cnaeus Lentulus the consul complaining in a public speech of the great power of Pompeius the Great, when the populace loudly applauded ; "Shout, citizens," cried he, "shout while you may ; soon you will not be permitted to do so unpunished."'

The *ad* in *adclamate* gives the notion of an applauding shout.

2. It is my delight to go to the forest, and when the deer are driven into the nets to cheer on the fleet hounds over the high ridges, or poise (lit., brandish) the quivering javelin with outstretched arm, or lay my limbs on the grassy earth : often it is joy to steer the light car over the dusty course, or guide my flying horse's head with the rein.

3. Diogenes at Syracuse, on Aristippus saying to him as he was washing some pot-herbs : 'If you wanted to flatter Dionysius you would not eat those things,' replied, 'Nay, if you wanted to eat these things, you would not flatter Dionysius.'

Esses is imperf. subj. of edo.

Ista sc. olera : the pronoun is contemptuous.

GREEK.

1. For a woman it is more seemly to stay at home than to gad about the streets, but for a man it is a reproach to stay at home rather than to take an interest in public business.

2. When Tithraustes offered rich gifts if he would quit the country, Agesilaus replied, 'With us, Tithraustes, it is held more honourable for a general to enrich his army than himself, and to endeavour to win spoils rather than receive gifts from the enemy.'

3. Of many issues is Zeus in Olympus the dispenser, and many do the gods accomplish against our hopes ; and so the expected event fails of fulfilment, whilst for the unexpected god finds a way.

(1) *ταμίας*, lit., a house-steward who distributes food to the household ; Lat., *dispensator ;* cf. '*dispensing* to every man severally,' etc.

For line 2 : 'God fulfils Himself in many ways.'—*Tennyson.*

(2) *ἐτελέσθη—εὗρεν.* These aorists are called *gnomic* aorists, as being the tense commonly used in proverbs (*γνῶμαι*) of what has occurred in the past, and, by implication, is liable to repeat itself. We use the present in English in such cases.

Force has already been defined to be the rate of change of momentum. Momentum is the product of the mass into the velocity = Mv, and as acceleration is rate of change of velocity, we can write $F = Mf$ where F stands for force, and f for acceleration. If we take a pound as the unit of mass and one foot per second per second as the unit of acceleration, the force will be expressed in poundals or British units of force. If we substitute a gram and a centimetre for a pound and a foot, the force will be expressed in dynes. In either case these units are called absolute units, inasmuch as they are independent of the force of gravity ; in each case a unit of momentum is produced in a unit of time. In the C.G.S. system, therefore, the unit of force is a dyne, and a mass of one gram in the latitude of London, and at the sea-level exerts a force of 981 dynes. In the foot-pound-second system the unit of force is a poundal, and a mass of one pound in the latitude of London and at sea-level exerts a force of 32·2 poundals.

Work.—Work is the act of producing motion in a body in opposition to a force that resists it. The work done in raising the mass of one pound through vertical foot is called a foot-pound. Thirty-three thousand foot-pounds per minute is called a horse-power, being the rate at which a horse can do work.

Energy is the capacity to do work. Work may be done by a moving mass in virtue of its motion or by a mass in virtue of its position or configuration. In the first case the energy is kinetic, in the second it is potential. It is in this potential form that energy can be stored up for future use. For measuring work we need an appropriate unit. For many years the foot-pound was used in this country. This is a gravitation unit, and varies with the force of gravity at the spot. We can, however, multiply the foot-pounds by the number representing the force of gravity at the place, and thus express the work in absolute units. In the C.G.S. system the unit of work is that done by the force of one dyne moving its point of application through one centimetre, or the work done in raising the $\frac{1}{981}$ part of a gram through one centimetre against the force of gravity in the latitude of London. This unit of work is called an *erg*.

Suppose a body to be projected vertically upwards with a velocity v; its velocity at any subsequent time is given by the equation $V^2 = v^2 - 2gs$. This velocity becomes less and less till the body ceases to rise. The equation then becomes $v^2 = 2gs$; that is, the vertical height through which the body would rise would be equal to $\frac{v^2}{2g}$. Now if M be the mass of the body in grams, the work done against gravity will be $\frac{Mv^2}{2g} \times g$ ergs $= \frac{Mv^2}{2}$ ergs. To find the energy of a moving body in ergs, multiply the number expressing its weight in grams by the square of the number expressing its velocity in centimetres per second, and divide the product by two. If a mass of one pound is moving with a velocity of 32·2 feet per second, it can do $\frac{Mv^2}{2g} = \frac{1 \times 32{\cdot}2 \times 32{\cdot}2}{2 \times 32{\cdot}2}$ = 16·1 foot-pounds, or $16{\cdot}1 \times 32{\cdot}2$ foot-poundals; if the mass of 10 grams is moving with the velocity of 100 centimetres per second, it can do $\frac{Mv^2}{2} = \frac{10 \times 100^2}{2}$ = 50,000 ergs. We see that both the unit of force and the unit of length enter into the unit of work: hence in reference to the fundamental units, Work $= Fs = \frac{ML}{T^2} \times L = \frac{ML^2}{T^2}$.

Suppose a mass of 10 lbs. be moving at the rate of 50 feet per second; it can do $\frac{5 \times 2500}{32} = \frac{12500}{32}$ foot-pounds of work in coming to rest. But if in doing so it has moved the point of its application through 2 feet, then since work is $= Fs$, its average force is equal to that of $\frac{12500}{2 \times 32} = 195$ lb.

We have said that force is measured by the rate at which momentum is generated. If much momentum is generated in a short time the force must be very great. Similarly, if a great momentum, *i.e.*, that of a heavy hammer moving with great velocity, be suddenly destroyed, the force it exerts is very great. The word impulse or impact is used to denote the action of a great force acting for a very short time. We have already seen (page 173) that $F = \frac{Mv}{T}$, *i.e.*, $FT = Mv$. Hence to generate or destroy a definite amount of momentum, the force we must employ will vary inversely as the time during which it acts. With a small hammer we are thus able to produce great effects. Suppose the hammer weighs a pound, and is made to move with a velocity of 20 ft. per second; its momentum will then be $\frac{1 \times 20}{32{\cdot}2}$: suppose this momentum is destroyed in the one five-hundredth part of a second, then from the equation $FT = Mv$ we find that F is = 3105 lb. A definite force acting for a certain time always generates the same amount of momentum; if the body acted upon be great, its velocity will be small, and *vice-versa*. The equation FT = momentum must not be confused with Fs = energy.

If a body of mass m, moving with a velocity v, strike a body of mass m_1, moving with a velocity of v_1, then, if they are inelastic, they will move on with a velocity V, and the algebraical sum of their momenta will remain unchanged.

Hence $mv + m_1v_1 = V(m + m_1)$.

$\therefore V = \frac{mv + m_1v_1}{m + m_1}$. This formula is easily adapted to the case where one of the bodies is at rest.

The student should make himself familiar with the metric system, and be not only able to repeat the tables but also to attach definite ideas to such words as gram, centimetre, etc. A rule about six inches long, marked in centimetres and millimetres can be bought for a halfpenny. With the aid of this the plane side of an ordinary ruler can be marked for the sake of practice. Then pieces of paper can be cut out to illustrate square measure. To get a clear idea of a cubic centimetre, one should be cut out in wood or paraffin. A block of wood one decimetre in the side is also useful to remind one of the volume of a litre which contains 1000 cubic centimetres. A cubic centimetre of water at 4° Centigrade weighs a gram, and a litre a kilogram. By measuring the lengths and capacities of familiar objects and expressing them in the decimal system, the student will gain a better acquaintance with it than by merely learning tables and working sums.

(*To be continued.*)

Recent Inspection Questions.

[*The Editor respectfully solicits contributions—all of which will be regarded as* STRICTLY PRIVATE—*to this column. For obvious reasons, it cannot be stated in which district the questions have been set.*]

Arithmetic.

STANDARD I.

(1) 579 + 16 + 800 + 7.	Ans. 1402.
(2) 950 − 74.	Ans. 876.
(3) 6 × 9	= Ans. 54.

STANDARD II.

(1) 19,048 × 58.	Ans. 1,104,784.
(2) 11,504 ÷ 9.	Ans. 1278 − 2.
(3) 19,047 − 10,854.	Ans. 8193.
(4) 110 pence = Ans. 9s. 2d.	Ans. 12 × 5 = 60.

STANDARD III.

(1) Divide 375,139 by 79. Ans. 4,748 – 47.

(2) Add £4,090 17s. 8¾d., £826 9s. 10½d., £70,005 14s. 6d., £53,687 8s. 5½d., £60 os. 9¾d. Ans. £128,670 11s. 4¼d.

(3) From £26,392 17s. 10d. take £9,541 19s. 3¾d. Ans. £16,850 18s. 6¼d.

(4) Eggs were bought at 10d. per doz., and sold at 1¼d. each, what was the gain? Ans. 5d. a dozen.

STANDARD IV.

A.

(1) Bring 453 hhds. 45 gals. 1 pint to gills (wine), and divide the answer by 347. Ans. 2,636.

(2) Reduce 5 years, 45 weeks, 5 days, 17 hours, 49 minutes to minutes, and write out the answer in words. Ans. 3,082,669.

(3) Bring one million cubic inches to yds., ft. Ans. 21 cub. yds., 11 cub. ft., 1,216 cub. inch.

(4) If I earn daily (not counting Sundays) a pound, a shilling, a penny, and a farthing, how much do I receive in a year? Ans. £330 5s. 7¼d. in 313 days.

N.B.—This question is inexplicit, as there might be 312, 313, or 314 days, exclusive of Sundays.

B.

(1) Bring four hundred thousand square feet to acres.

Ans. 9 ac. 29 p. 6¾ sq. yd. 4 ft; or, 9 ac. 884 sq. yd. 4 ft.

(2) What is the difference in ounces between 4 cwt. 2 qrs. 17 lbs., and 1 cwt. 3 qrs. 27 lbs? Ans. 4,768 ozs.

(3) Bring 73 days 3 hrs. 24 min. to minutes, and write the answer in words. Ans. 105,324.

(4) A man bought 15 cwt. of rice for £24 10s.; how must he sell it per lb. to gain exactly £7. Ans. 4½d.

STANDARD V.

(1) The carriage of potatoes for 60 miles 6 fur. was £12 12s. 10½d.; what distance could they have been sent for £37 18s. 7½d.? Ans. 182¼ miles.

(2) Bill:—

17½	gross of pens at 3d. per doz.
15	reams of paper at 1s. 9½d. per quire.
18	score of pencils at 4½d. per doz.
1000	slate pencils at 19½d. per 50.
119	quires of paper at 1d. per sheet.

Ans. £43 11s. 9d.

(3) Find by practice the cost of painting a door 3 yds. 7 inches long, and 2 yds. 2 feet wide, at £10 per sq. yd. Ans. £85 3s. 8⅛d.

N.B.—A question in mensuration, at a ridiculous price per sq. yd.

(4) $(7\frac{1}{3}+9\frac{1}{4})-(6\frac{1}{2}+\frac{1}{5}+1\frac{3}{10})$. Ans. $8\frac{17}{60}$.

STANDARD VI.

(1) Simplify $\frac{7\frac{1}{3}-6\frac{1}{8}}{8\frac{1}{9}+11\frac{1}{5}} \div \frac{\cdot073+\cdot07}{\cdot73-\cdot073}$ Ans. ·2874+

(2) Reduce $\frac{2}{5}$ of £1 to the decimal of 1 guinea. Ans. ·380952.

(3) Find the value of 13·3375 acres. Ans. 13 ac. 1 rd. 14 per.

(4) If 20 men in 3 weeks earn £90, in what time will twelve men earn £150? Ans. $8\frac{1}{3}$ weeks.

(5) Find simple interest on £719 17s. 9d. for 5½ years at 2½ p. c. Ans. £98 19s. $8\frac{23}{50}$d.

Grammar.

STANDARD IV.

Parse:—

(*a*) He quickly came to blows with the enemy.

(*b*) The sight of distress always fills a benevolent mind with compassion.

STANDARD V.

Parsing and analysis:—

(*a*) Tell me nothing but the truth.

(*b*) Why have you kept this intelligence so long from us?

Dictation.

STANDARD I.

Shoe, chain, collar, shirt, neck.

STANDARD II.

Suddenly an awful storm came on. The wind blew fiercely, and great clouds of sand were lifted into the air—clouds which darkened the sun! The merchants at once jumped off their camels, covered themselves with their cloaks, and lay down; while the poor beasts closed their nostrils.

STANDARD III.

So he roams about, turning the furniture upside down; he lies on his face to peep under sofas and beds, and dirties his shirt. Failing to find the shoe, he accuses his brother of having concealed it; for a careless fellow admits his want of order only at the last extremity. It was so much the more unlucky because his mother, after reproaching him for wasting his shoes, had ordered two pairs for him; and the tradesman, as is too common, had not brought them on the day he promised, so that, for the time, he was reduced to a single pair.

STANDARD IV.

The animal was evidently in great pain, and, on passing his hand over her body, he discovered that one of her legs was fractured. He accordingly bound it up with his garter, and offered her some of his bread; but she refused to eat, and stretched out her tongue, as if her mouth was parched with thirst. He gave her water, which she drank greedily, and then she ate the bread. At midnight he ventured out, pulled a quantity of grass and tender branches of trees, and carried them to the poor sufferer, who received them with demonstrations of gratitude.

—o—

WE have received a copy of 'Hygiene' by our esteemed and able contributor, Dr. Newsholme. For obvious reasons this work cannot be noticed in the columns usually assigned to Reviews. We will therefore simply state that the doctor is eminently qualified, both as a scholar and practical teacher, to deal with this new subject of the Science and Art Department, and that he has given us an excellent, comprehensive, and reliable text-book.

Messrs. Gill and Sons, the publishers, have issued the volume in a highly creditable style.

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Portfolios, fitted with elastic bands, for preserving twelve numbers of 'The Practical Teacher,' may now be had. Price 2s. 6d. Orders should be given through booksellers.

The numbers of the *Practical Teacher* for February and March, 1884, are now out of print.

Publications Reviewed.

How Sorrow was Changed into Sympathy. By Mrs. Prentiss. London: Hodder and Stoughton.

This is a posthumous work by the well-known author of 'Stepping Heavenward.' It describes with the fullest imaginable detail the sufferings and death of two of Mrs. Prentiss's children—a little boy of four, who died of a brain affection, and a baby of a few weeks old, who succumbed to congenital feebleness. There is really nothing remarkable in the story. The little boy is not represented as phenomenally bright or exceptionally interesting. He used to eat strawberries with a pin, but this he seems to have been taught, not to have originated. His little sayings displayed no more cleverness than is common with fairly bright children. The details of the poor little fellow's illness, however, are made painfully interesting by the minuteness with which they are given. The symptoms, the sufferings, the very cries of pain are chronicled as carefully as a mother's heart might be expected to retain them for long after; but there is something cruel in the gratuitous harrowing up of the reader's sympathies by such details. One of the most painful experiences that can come to man or woman is to have to watch the anguish of a little child. Why should we thus suffer without need and vicariously through such a book as the one before us? Here are some specimens of its distressing descriptions: 'About dusk he manifested great distress, and tore hair from his head in handfuls, which I took from his clenched fingers and laid aside. . . . . He was tortured with constant nausea. . . . . His cries were fearful, and rent my heart. . . . . He appeared to sleep until the blister began to draw, when he cried out at intervals till five a.m., "O mamma! my neck!" in accents of distress which my ears will ever hear.' We do not know what advantage it can be to any one to read this kind of pitiful story, though the passion and reality with which it is told certainly give the book a curious interest when once begun.

The latter fourth of this little volume's pages are filled with letters written by Mrs. Prentiss to other bereaved mothers, ardently exhorting them to pious resignation and submission to the will of God. They are well and fervently expressed, and place powerfully before the reader all the ideas and hopes by which a Christian mother may partially solace her soul for the loss of her children. The book is handsomely bound.

Domestic Economy. By E. Rice. London: Blackie and Son.

This is one of the best *practical* books on Domestic Economy that we have seen. The writer, the late Mistress of Method at Cheltenham Training College, is evidently also an experienced housewife. Nothing could be clearer or more sensible than all her remarks and descriptions about the practical work of a household, from washing blankets or cleaning grates to managing children or cooking for the sick room. We wish we could speak with equal warmth of the scientific portion of the book. Let us hasten to say that on the whole this is accurate. It fails sometimes in fulness. For example, the necessity for gradually increasing the strength of an infant's milk diet, when it is 'brought-up by hand' is not mentioned. The instruction is twice repeated to mix for a baby one part of water with two of milk. This would be too strong for an infant of a few weeks old, and far too weak for one of seven months. Analysis shows that nature accommodates the strength of the child's natural food to its growing demands; and the same indication should be followed in artificial feeding. Sometimes Miss Rice falls into the contrary error to this in teaching theories which science would not justify. The writer is evidently a homœopathic, for she advises the domestic use of aconite, pulsatilla, calendula, and other drugs which are strange in the ears of orthodox medical practitioners, and which, to say the least, untrained women had better not pour into themselves or their children. She even goes so far as to advise the amateur to take daily doses of belladonna as a prophylactic against scarlet fever; a very questionable piece of practice for any one, and a most improper thing to be done at random by a working man's wife, whenever she gets a scare about the prevalence of fever. These errors in practical recommendation about scientific points are in marked contrast to the excellence of the practical suggestions about what Miss Rice does understand—domestic management pure and simple. She has simply

read up her science. It has not grown to be a part of the furniture of her mind. The clearness and easiness which are so charming in her style when treating of the details of cooking and cleaning are lost in the chapters on the 'Composition of Animal Tissue,' 'Mineral Food,' 'Digestion,' and the like topics. School-girls will not understand, if left to themselves, one word of her description of gases and elements and the like. Nor would it be any use to them to learn by rote such statements as, 'The food is first taken to the mouth, and this act is called PREHENSION'; or 'scalded milk is very good in *affections of the alimentary canal*,' or 'the word "gas" was never *known* till about the year 1644,' and a multitude of other more verbose and similarly useless assertions in long phraseology, which we have not space to quote. The teacher must fill out for herself the very dry bones which are all that are here presented of the scientific side of the subject, if she use Miss Rice's book. But of the practical part, we can fairly say that it would be well if every girl got it thoroughly by heart in her school-days.

The Science of Home Life. Third Year's Course. By W. Jerome Harrison, Science Demonstrator to the Birmingham School Board. London: T. Nelson and Sons.

Mr. Harrison's work is precisely the reverse of the one above reviewed. Here the science is capital, but the practical part is comparatively stunted and meagre. The topics treated are those of the third stage of domestic economy according to Schedule IV.—namely, the preparation of food, the care of health, and the management of the sick-room. The earlier chapters give an outline of human physiology, and explain the science of alimentation. This is all done admirably. We have never seen such a concise and clear exposition of these matters in so small a space. In every part of the work, reasons are given for the rules laid down. The pupil is not required here, as is so often the case in manuals on this subject, to believe certain things to be true simply because the author of the text-book has written them down, and the printer has put them in type. We have repeatedly expressed our conviction that domestic economy taught in this *ex cathedrâ* style is nearly useless, and the same judgment may be found set forth over and over again in the reports of H.M. Inspectors printed in recent blue-books. Mr. Harrison's work is a model of method in this respect. For every rule he gives a reason, and his pupils will thus not only comprehend him more completely, but will also realise the value of his teachings, and be likely to practically apply them in after life. Recipes and cookery instructions are, however, a weak point with Mr. Harrison. An intelligent woman could certainly infer the whole art of cookery out of the very full account which he gives of the principles that govern the various culinary operations, of the utensils employed in the kitchen, and of the meats and vegetables available for food. But he does not himself trace the connection between each scientific principle and the practical cookery dependent on that principle. It is true that a well-trained mind will draw this kind of deduction readily enough; but for the class for whom Mr. Harrison writes—school-girls of twelve and thirteen—the task should be undertaken by the teacher. A perfect work on the subject requires both theory and practical knowledge.

'Both butter and cheese are best eaten as they are, without any attempt at cooking them.' Does any sane creature try to cook butter as a separate *plat?* Or is this sentence aimed at melted butter? Did Mr. Harrison ever try a rice pudding made precisely according to his directions? Or does any practical cook think the following sufficient instructions in the art of making short paste: 'To make suet paste chop one quarter of a pound of suet, and mix it well with half a pound of flour; make it into a stiff paste with water, and roll out with a rolling pin. Short paste is made in the same way, but with dripping or lard instead of suet, and with the addition of a small teaspoonful of baking powder.' We draw attention to this point, not because it is of great consequence, for cookery classes are now common, and this deficiency will be made good there for the girls, but mainly because a little more care in this respect would make Mr. Harrison's quite a perfect manual of the subject.

The volume is illustrated. A special feature is the introduction of diagrams of the jointed forms of the various animals used as food, with a key giving the butcher's names for the various parts. This will be incalculably useful to young beginners in purchasing the household provisions. We recommend teachers of domestic economy to obtain this work, for it has real scientific value.

New Royal Readers. Nos. III. and IV. London: T. Nelson and Sons.

We can speak of these Readers in terms of approbation as warm as we gave to the preceding books of the same series. The matter is well selected, the illustrations are fresh, the type is clear, and the paper good.

In the Standard III. Reader, the first of the two volumes now before us, the selections are miscellaneous, and have the advantage of being new for the most part. Questions, spellings and meanings, grammatical exercises, and a précis of the matter, are appended to each lesson. Verse is scattered throughout, but a special selection of poetry for recitation, with the accents carefully marked, is placed at the end of the volume, where, also, there are a few school songs, with music in both notations.

In the Standard IV. book a novelty is introduced in a series of consecutive readings from 'Uncle Tom's Cabin.' The story is completely told, although, of course, much shortened, the actual quotations from Mrs. Stowe's famous work being linked together and made into a continuous narrative by well-written paragraphs from the pen of the editor. Every possible assistance is given both to teachers and children in this series. The Royal Readers have always been popular, and this new series, adapted to the latest requirements of the Department, will doubtless be warmly greeted by teachers.

Blackie's Geographical Readers. Nos. III. to VII. By W. G. Baker. London: Blackie and Son.

This is an excellent series of Geographical Readers. All are well illustrated, both with a profusion of maps, plain and coloured, and with pictures of some of the various scenes described. A useful summary concludes each volume; these contain, of course, greatly condensed information, and thus, for all their utility, may be called dull, but they are the only dull pages in the books. A large portion of these volumes consists of quotations from famous books of travel, sometimes taken verbatim, sometimes (in the earlier books) verbally adapted to the standard which is to read them. Even newspapers and magazines are laid under contribution. 'Scenes in Kent,' for instance, comes from the *Argosy*, and a description of the Yarmouth fisheries from the *Illustrated London News*. A speech of the Duke of Edinburgh is drawn upon for one page, and Nathaniel Hawthorne's 'Old Home' for another. This we mention to indicate how varied the contents of these Readers are.

Book III. deals with England and Wales. After a general outline introduction, treating of the size, shape, and situation of these islands, some chapters are devoted to explaining the meaning of the terms 'coast' and 'seashore.' The young reader is then taken round the coasts; next to the principal hills; and then along the chief rivers. Succeeding chapters describe the principal large towns, and the manufactures of which they are the seat: and the book concludes with a study of the counties in groups. We repeat that there is nowhere a dull page. It is not mere dry cataloguing, but bright, vivid description; and the pictures of the principal buildings, chief streets, interiors of workshops, etc., add greatly to the interest.

Book IV. treats of Scotland, Ireland, and the principal

British Colonies. The frontispiece is a map of the world, showing the British possessions coloured red. This volume has the addition of a few pieces of verse of much interest. One called 'Settlers' Difficulties' is stated to be the first recorded poem written in America, and is dated 1630. Another old poem is described as having been written by a waterman of London in the time of James I., and is descriptive of the Anglo-Scottish border. Accounts of the adventures of emigrants and explorers will be an attractive feature of this volume to the young reader.

Number V. is the volume devoted to Europe, and has an excellent coloured map. The names of the Continental towns are spelt phonetically in brackets, so that the little student will have no difficulty in learning the pronunciation. Amongst the many fine illustrations in this book, we may single out for special mention that of the Isak Square, St. Petersburg, which is really beautifully drawn and engraved. This volume concludes with a clear explanation of what is meant by latitude and longitude, and of the revolutions of the earth.

Asia, Africa, and America are dealt with in Book VI. Amongst the authors who are drawn upon in this volume are Dean Stanley, Lady Brassey, A. R. Wallace, and Anthony Trollope. The final volume, No. VII., deals to some extent with physical geography and the planetary system, and includes a long series of extracts from 'The Voyage of the *Challenger*.'

We can only conclude by saying that these are models of what geographical readers should be. Criticism might, perhaps, be exercised upon some small details. The sketch which is given of the system of Government in England appears to us, for example, quite inadequate, and we think it would have been better to omit this topic altogether, rather than to have treated it in a manner so perfunctory as to be extremely likely to mislead. Taking the books as a whole, it would be difficult to give them praise which should exaggerate their merits.

A Practical and Philological Text-Book on the Analysis of Sentences, Parsing, and Punctuation. Specially adapted for the use of Schools and Colleges. By John J. Jones. London: Longmans, Green and Co.

There is, perhaps, no subject of English instruction on which a greater number of text-books have been written than on grammar. From large and costly folio volumes, down to penny 'Standard Grammars,' there is a bewildering choice, of varying degrees of excellence, and of great diversity of plan. The writer who adds another to the list ought surely to have something special to say, either as to the matter itself, or to its mode of treatment. And this much may be fairly conceded at once to the author of the book before us. It is an elaborate and very carefully-written treatise, divided into four chapters, which treat successively of Simple Sentences, Complex Sentences, Compound Sentences, and Punctuation, followed by an Appendix which deals with the Structure of the Verb, and the Structure of the Predicate. It is intended for somewhat advanced scholars, the pupil being 'supposed to be able to parse tolerably well before he enters upon the study of this Text-Book.' This may explain, if it do not altogether justify, the somewhat difficult style of expression and choice of words employed in many of the Definitions, and the Directions to the Pupil. Thus, among Preliminary Explanations, in Paragraph 1 is this: 'To analyse a sentence is to break it up into its constituent and compound elements.' One of the first directions given to the scholar is, 'Analyse the appended examples as per Plan I.' Such words and phrases make considerable demand on the knowledge and intelligence of an average schoolboy, at the stage at which the analysis of sentences is usually begun. There is no lack of clearness in the author's style when once the words are understood; and, doubtless, the teacher using the book is expected to give the necessary explanations. But simpler language would be an advantage to teacher and learner, and would detract nothing from the excellence of the book, but would the rather add to its value.

The structure of English sentences, from the simplest to the most complex, is minutely detailed in the order indicated above. The plan adopted is to illustrate and explain each successive element, and the mode of its analysis, in due order. This is followed by a series of examples to be treated by the pupil after the pattern set by the teacher, and these again by 'Lessons,' to be worked as examination papers. A feature of special excellence is the choice and gradation of examples. We have nowhere seen anything equal to these, for number, variety, and admirable adaptation to their purpose. Out of the hundreds of sentences selected as examples, we notice none that are not good in themselves, and well adapted for their purpose. The simplest are not silly, while among the more advanced are some of the choicest expressions, both of thought and of style, which the language affords. The works of many of the best writers of English have been laid under contribution. A list of the authors, specimens of whose style furnish the illustrations and examples, would comprise the names of many of the foremost literary Englishmen, from Chaucer to the present day. The labour of selecting these examples must have been great, and it is labour well applied.

'Following each successive stage of analysis, instruction is given in Parsing' This seems to us to be the only true method of teaching Parsing, for, as is well shown by the author, both analysis and parsing depend, for their clear understanding, upon 'the different functions of words and their mutual bearing.' Complete and careful instruction is given on the relation of these two parts of grammar to each other. Idiomatic difficulties are explained in great detail, and every part of the subject is dealt with in an able and scholarly manner.

The chapter on Punctuation, that too-sadly neglected element of style, is most valuable. All the 'marks used for punctuation and for various other purposes' are given, and are fully dealt with, both by way of explanation and illustration. Common errors are pointed out, and an abundant series of examples furnished for illustration and for practice.

The Appendix, dealing with the Structure of the Verb and of the Predicate, the author introduces with the remark that it contains 'matter too abstruse for ordinary school purposes, and, in a few instances, dwells upon points that must be considered debatable ground.' He speaks of what he here advances as 'the offspring of many years' patient study,' and he deprecates 'hasty criticism,' or 'too ready condemnation' of what may at first appear to be unwarrantable.

Into this debatable ground we will not enter. In it will be found a careful discussion of the conjugation of the English Verb, including a defence of the Potential Mood, which has been so summarily set aside by some recent grammarians, and an elaborate exposition of Voice, Tense, and Mood, with their bearing on intricate and misunderstood points of idiom and of style. This, at least, may be said, that no opinion is advanced by the author which is not sustained by sound argument and sensible exposition.

We heartily commend this work to the careful perusal of teachers who desire for their pupils a clear and intelligent presentation of the structure and functions of our noble English speech.

The book has been carefully edited, and overlooked errors are few. An unfortunate example of one, however, is to be found on page 176, in the quotation from the ninth chapter of St. John's Gospel, where the present indefinite of the subjunctive mood '*be*,' has been substituted for the past indefinite.

Descriptive Botany Tables. By C. H. Octavius Curtis. Lymington: H. Doman.

This is a remarkably clear and accurate tabular guide to the description and classification of plants.

A Summary of English History. Designed for the Use of Schools. By Llewellyn C. Burt, Barrister. London: Simpkin, Marshall, and Co.

Of the various methods of teaching history, followed by writers of text-books on the subject, two are chief. One is by giving a general knowledge of the story of the past by vivid, interesting narration and description, utilizing the ready eagerness common to young and old of listening to good 'story-telling'; then helping the memory by short summaries of selected and arranged dates, names, and events. The other is by presenting first the bare, disjointed outline of 'facts' to be committed to memory, and clothing them with details afterwards, if at all.

There is no lack of books of both kinds. Those teachers who prefer the latter method will find this little book convenient for their purpose. Here is a skeleton of English history, fairly complete, compact, and necessarily 'dry.' It has the usual features of such summaries: chronological arrangement of the principal facts; tables of the genealogies of the several royal houses, somewhat pedantically spoken of as 'Regnal Tables'; special paragraphs of notes, describing important matters, as the Habeas Corpus Act, the Magna Charta, House of Commons, etc., and also brief accounts of eminent persons, under the heading, 'Names of Note.'

It is claimed as 'the distinctive feature of these Tables' that 'each reign is, with a few exceptions, divided into a *uniform number of sections (four)*. By this means it is believed that the memory of the pupil will be greatly assisted.' Probably it will. But it involves the very doubtful advantage of equalising the space, and the number of events, in reigns of such diverse length and importance as those of Henry III. (fifty-six years) and Richard III. (two years); in the comparatively uneventful reign of Edward II. (twenty years), and the more stirring times of his father, Edward I. (thirty-five years), and of his son, Edward III. (fifty years); and it finds four sections, neither more nor less, for each of the reigns of Henry VIII. (thirty-eight years), of his son Edward (six years), and his daughters Mary and Elizabeth (five, and forty-five years, respectively). It is inevitable that such an arrangement must bring into prominence some events of small moment, and omit many of great importance.

The value of such books necessarily depends greatly on the method in which they are used. If children 'at an early age,' to quote from the preface, are required, as an approach to the study of history, to commit to memory the dry and detached details contained in the pages of this book, the probability is that many will suffer the great educational evil of acquiring a permanent dislike to the records of the past. But if those records be presented to them in language and style suited to their age and capacity, and with something of the picturesqueness of Mr. Green's 'Shorter History of the English People,' and this book be afterwards used to give definiteness and precision to the order and relative position of the facts, it will serve a useful purpose.

The book is one of the best of its kind, albeit the kind is one that eminently favours that bane of teaching in the present day—cramming for examinations.

Notes of a Course of Lectures on Commercial Geography. By the Rev. L. C. Casartelli, M.A., Professor of Commercial History and Geography in St. Bede's College, Manchester. Manchester: J. B. Ledsham.

This is an excellent book in all respects, both as a manual for the teacher and a book of reference. The subject is one of the highest practical value in a trading community such as ours, and its treatment in this little work, of less than 120 pages, is highly satisfactory.

These most carefully compiled 'Notes' were drawn up by the author for his use in preparing classes for the examinations in Commercial Geography and History, instituted some years ago by the Lancashire and Cheshire Union of Institutes. The best works on the subject, German, French, as well as English, have been laid under contribution, and the result is an admirable compendium of information on the industries and commerce of all the trading countries of the world. The matter is compact, and its excellent arrangement in Chapter I., 'The British Isles,' is followed in dealing with other countries so far as the differences in their conditions admit. The several matters treated of are: Population, Climate and Soil, the relation of these to natural products, and consequent Industries in distinct localities, Agriculture, Food and Drink Industries, Mineral Produce and Metal Trade, Hardware, Potteries and Glass, Textile Trades, Ports, and Shipping.

There are valuable chapters on Trade Routes, the Chief Ports of the World, Railways, Canals, and Telegraphic Communication; and Appendices giving 'Our Trade Account' with other countries, and a comparison of the Commercial Statistics of the British Empire with five other commercial nations.

The book is well printed,—paragraphs, headings, and various types, greatly facilitating the clear presentation of the matter.

Altogether this brief epitome of Trade Geography is unique in scope and completeness, and we highly commend it for the actual value of its contents, as well as for its suggestiveness to teachers.

—o—

Publications Received.

Blackie and Son—
An Epitome of History by Carl Ploetz.
Vere Foster's Simple Lessons in Water Colour. Pts. 1, 2, 3, and 4.
Blackie's Geographical Readers. Nos 4, 5, and 6.
A Text-Book of Domestic Economy. By E. Rice.

Cassell and Co., Limited—
Introductory Lessons in Geography. St. I.

Chambers (W. and R.)—
Chambers' Geographical Readers. Standards III. and IV.

Heywood (John)—
The Paragon Reader. St. V.
Graduated Exercises in English Grammar. By M. Hickey.

Letts, Son, and Co., Limited—
Letts' Illustrated Household Magazine. July.

Longmans and Co.—
Longman's Magazine for July.
Macaulay's Essay on Milton. Edited by A. Mackie, M.A.
A Text-Book on Practical Solid or Descriptive Geometry. By D. A. Low.
White's Latin-English and English-Latin Dictionary.

Murby (T.)—
Murby's Scripture Manuals—Judges.

Nelson and Sons—
The New Royal Reader, No. 5.

Relfe Bros.—
A Digest of English History, 1689-1760. By M. Gutteridge, B.A.

Rice (William)—
Oxford and Cambridge Local Examinations in Arithmetic, with Answers, 1858-1883. By R. Oscar T. Thorpe, M.A.

Smith, Elder, and Co.—
Cornhill Magazine. July.

Stewart, W., and Co.—
Outlines of Mental Philosophy. By Dr. Mcrell.

Swan Sonnenschein and Co.—
Handbook of Agriculture. By R. W. Ewing.
The Logical English Grammar. By F. G. Fleay, M.A.
The Musician—Third Grade. By Ridley Prentice.

Query Column.

RULES.

1. Each correspondent is restricted to *one question.* We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.

2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.

3. ☞ **When a pseudonym is adopted it should be written at the end of the query, and the real name and address on a separate piece of paper.**

4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.

5. Replies will not be sent through the post.

6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—'*The Query Editor*,' *The Practical Teacher, Pilgrim Street, Ludgate Hill, London, E.C.*

Arithmetic.

1. MONITOR.—(1) The true discount on a bill of £83 9s. 6d., due fifteen months hence is £3 19s. 6d.; what is the rate per cent? (2) I receive £3 19s. 6d. as true discount at 4 per cent. on a bill of £83 9s. 6d., when is the bill due? (*All-the-year round Test Cards.*)

(1) Present value of bill = £83 9s. 6d. − £3 19s. 6d.
= £79 10s.;

£	£	£ s. d.
79½	100	3 19 6 : Rate per cent.
yrs.	yr.	20
1¼	1	79
		2
		159

∴ Rate per cent. = $\frac{\not{£}\not{\emptyset}\not{\emptyset} \times 4 \times \not{1}\not{5}\not{9}}{\not{7}\not{9}\not{5} \times \not{5} \times \not{4}\not{\emptyset}}$
= 4. Ans.

(2) Interest for 1 year on present value of bill
= 4 per cent. on £79 10s.
= £3·18:

£	£ s. d.	year.
3·18	3 19 6	1 : Time.

$\not{3}\cdot\not{1}\not{8}$: $\not{3}\cdot\not{9}\not{7}\not{5}$ :: 1 : Time.
2 2·5
= 1·25 years
= 15 months. Ans.

2. MAGISTER.—(1) A clock, which loses 10 secs. per hour, is set to the correct time at 9.15 a.m. on Monday. What will be the correct time by the clock, when its hour and minute hand point in exactly opposite directions between 9 and 10 o'clock p.m. in the evening?

(2) How must the hands be altered so that the clock may show the correct time at noon on Tuesday? (*Barnard Smith's* 'Examination Papers in Arithmetic.')

(1) The hands will be exactly opposite between 9 and 10 at (15 + $\frac{4}{11}$ of 15) min. past 9
= $16\frac{4}{11}$ min. past 9;
Time from 9.15 a.m. to 9.$16\frac{4}{11}$ p.m.
= 12 hrs. $1\frac{4}{11}$ min.
= 12 hrs. 1 min. $21\frac{\circ}{11}$ sec.;

min.	sec.	hrs.	min.	sec.	sec.
59	50	12	1	$21\frac{\circ}{11}$	1ø : Time lost.
60		60			
3590		721			
11		60			
3949ø		43281			
		11			

)476100(120$\frac{2}{3}\frac{2}{6}\frac{7}{7}\frac{0}{5}$ secs.
3949
8120
7898
2220

∴ Correct time = (16$\frac{4}{11}$ min. + 120$\frac{2}{3}\frac{2}{6}\frac{7}{7}\frac{0}{5}$ sec.) past 9 p.m.
= (16 min. $21\frac{9}{11}$ sec. + 2 min. $0\frac{2}{3}\frac{2}{6}\frac{7}{7}\frac{0}{5}$ sec.) past 9 p.m.
= 18 min. $22\frac{1}{11}\frac{8}{3}\frac{2}{6}\frac{3}{7}$ sec. past 9 p.m. Ans.

(2) Time from 9·15 a.m. on Monday to noon on Tuesday = 26¾ hours;

hr.	hrs.	sec.	
1	26¾	10	Time lost.
	10		
6,0	26,7ø sec.		

4 min. 27$\frac{1}{2}$ sec. Ans.

3. R. W. K.—Show that it is better for a clerk to have his salary increased by £5 a half-year than by £20 a year.

Advantage 1st year = £5;
" 2nd " = (£10 + £15) − £20
= £25 − £20
= £5;

In 1st case there is an increase of £20 annually, and salary for 1st year is £5 higher;
∴ Advantage = £5 yearly.

4. W. H. W.—The discount on £566 10s. for 9 months is £16 10s.; find the rate of interest.

Present worth = £566 10s. − £16 10s.
= £550;

£	£	£
550	100	16½ : Rate per cent.
yr.	yr.	
¾	1	

∴ Rate per cent. = $\frac{\not{1}\not{\emptyset}\not{\emptyset} \times 4 \times \not{1}\not{6}\not{5}}{\not{5}\not{5}\not{\emptyset} \times \not{3} \times \not{1}}$
= 4. Ans.

5. J. W.—The discount on a certain sum for 2½ years is $\frac{80}{87}$ of the interest. What is the rate per cent.?

Interest − Discount = Interest on the Discount;
∴ Interest − $\frac{80}{87}$ of Interest = Interest on $\frac{80}{87}$ of Interest,
$\frac{7}{87}$ of Interest = Interest on $\frac{80}{87}$ of Interest,
7 times Interest = Interest on 80 times Interest,
Rate per cent. × 2½ × 7 = (Rate per cent. × 2½ × 80) × $\frac{\text{Rate per cent.} \times 2\frac{1}{2}}{100}$

$7 = 80 \times \frac{\text{Rate per cent.}}{40}$
= Twice Rate per cent.,
∴ Rate per cent. = 3½. Ans.

6. SARCOPHAGUS.—An agent has to receive a rent paid in corn from a tenant, and deliver it to the landlord. At each payment he uses, so as to benefit himself, a false balance, such that 9 lbs. in one scale balances 10 lbs. in the other. Corn being worth 49s. a quarter, the value of his plunder is £46 11s. What is the corn-rent? (*Hamblin Smith.*)

Quantity plundered = $\frac{1}{10}$ of whole ;
Quantity of plunder in qrs. = £46 11s. ÷ 49s.
= 931s. ÷ 49s.
= 19 ;
∴ Corn-rent = (19 × 10) qrs.
= 190 qrs. Ans.

7. FOLKESTONIAN.—A young clerk is offered a salary of £50 a year, with his choice of an increase of £2 per quarter, or of £35 per year. Compare the sums total of his earnings at the end of five years, according as he adopts one or the other alternative. (*Pupil Teachers' Examination.*)

		£
First year's salary of first offer = £(50+2+4+6)		= 62
Second ,, ,, ,,	= £(50+8+10+12+14) or £{62+(8×4)}	= 94
Third ,, ,, ,,	= £(50+16+18+20+22) or £{94+(8×4)}	= 126
Fourth ,, ,, ,,	= £(50+24+26+28+30) or £{126+(8×4)}	= 158
Fifth ,, ,, ,,	= £(50+32+34+36+38) or £{158+(8×4)}	= 190
Total salary for 5 years of first offer		= £630
,, ,, ,, second ,,	= £[50×5+{35×(4+3+2+1)}] = £{250+(35×10)} = £(250+350)	= 600

∴ Difference = £30

8. SUSIE.—A person has ·1875 part of a mine ; he sells ·17 part of his share ; what fractional part of the mine has he still left ? (*Barnard Smith.*)

He has ·1875 = $\frac{3}{16}$ part of the mine ;
He sells ·17 = $\frac{17}{100}$ = $\frac{37}{200}$ part of his share ;
∴ He has left $\frac{37}{200}$ of $\frac{3}{16}$ = $\frac{111}{3200}$ part of the mine. Ans.

Note.—Perhaps 70 per cent. Your writing lacks regularity.

9. YORKSHIREMAN.—A person has £1475 in the 3 per cents. at 83½. When the funds have fallen 2½ per cent., he transfers his capital into the 5 per cents. at 108. Find the alteration in his income.

Income in 1st case = 3% on £1475
= £44 5s. ;

£ £ £
$\frac{166}{4}$: $\frac{81}{3}$ :: 1475 : Stock in 2nd case.

3
4 | 4425
£1106¼

Income in 2nd case = 5% on £1106¼
= £55 6s. 3d. ;
∴ Alteration in income = (£55 6s. 3d. − £44 5s.) increase
= £11 1s. 3d. increase. Ans.

10. WELSHMAN.—A invests £4625 in railway stock at 125 ; B invests £4900 in another at 120. A receives an annual dividend at the rate of 4½ per cent., and receives £3 10s. more than B. At what rate was the annual dividend to B calculated ? (*Certificate*, 1881.)

A's dividend = $(\frac{4625}{125} \times 4\frac{1}{2})$£
= $\frac{37 \times 17}{4}$£
= $\frac{629}{4}$£
= £157 5s. ;
B's ,, = £157 5s. − £3 10s.
= £153 15s. ;
∴ Annual dividend of B's stock
= $(153\frac{3}{4} \times \frac{1}{4900})$ per cent.
= $\frac{615}{4 \times 41}$ per cent.
= $1\frac{1}{4}$ per cent.
= 3¾ per cent. Ans.

11. ROGO.—What is the least number which if divided by 43 and multiplied by 41 will leave 18 for a remainder ?

Difference between 43 and 41 = 2 ;
For No. 1 the remainder = 41 ;
For remainder 9, Least No. = {(41 − 9) ÷ 2} + 1
= 16 + 1
= 17 ;
∴ ,, 18, ,, = 17 × 2
= 34. Ans.

12. J. EDWARDS.—A vessel making for a harbour fires a signal gun ; the flash is seen from the harbour, and the sound follows in 22½ sec. ; a tug puts off at once and steams straight to the vessel at 12 miles an hour, and from the vessel 5 min. afterwards, the flash of a second gun is seen, the sound of which follows in 15 sec. If sound travels 13 miles per minute, at what rate is the vessel approaching the harbour, and how soon after starting will the tug meet her ? (*Lower Division*, October, 1883.)

Distance of vessel from harbour when first gun is fired
= 13 miles × $\frac{22\frac{1}{2}}{60}$
= $\left(13 \times \frac{45}{120}\right)$ miles
= $4\frac{7}{8}$ miles ;
Distance of vessel from tug when second gun is fired
= 13 miles × $\frac{1}{12}$
= $3\frac{1}{4}$ miles ;
∴ Distance gone by vessel in 5 min. = {$4\frac{7}{8}$ − ($3\frac{1}{4}$ + 1)} miles
= $\frac{3}{8}$ mile ;
∴ Rate of vessel = ($\frac{3}{8}$ × 12) miles per hour
= 7½ miles per hour. Ans.

∴ The tug will meet the vessel in

$\frac{4\frac{7}{8}}{7\frac{1}{2} + 12}$ of an hour
= $\frac{4\frac{7}{8}}{19\frac{1}{2}}$ of an hour
= $\left(\frac{39}{8} \times \frac{1}{39}\right)$ of an hour
= $\frac{1}{4}$ hour
= 15 min. Ans.

13. MONSTER.—A man walking forward on a ship, steaming with the tide, has an absolute motion of a mile in 3½ min. ; if the tide were running the other way, his absolute motion would be a mile in 6 min. ; while if in this latter case he turned and walked towards the stern, his absolute motion would be a backward one, at a mile in 30 min. Find rate per hour of walking, steaming, and of the tide.

Absolute rate per hour in first case = $\frac{60}{3\frac{1}{3}}$ miles
= 18 miles ;
,, ,, second ,, = $\frac{60}{6}$ miles
= 10 miles ;
,, ,, third ,, = $\frac{60}{30}$ miles
= 2 miles ;

Rate of walking + Rate of steaming + Rate of tide = 18 miles
Rate of walking + Rate of steaming − Rate of tide = 10 miles

Subtracting, Twice Rate of tide = 8 miles,
∴ Rate of tide per hour = 4 miles.

Rate of steaming + Rate of walking + Rate of tide = 18 miles
Rate of steaming − Rate of walking − Rate of tide = 2 miles

Adding, Twice Rate of steaming = 20 miles,
∴ Rate of steaming per hour = 10 miles.

∴ Rate of walking per hour = 18 miles − (10 + 4) miles
= 4 miles.

14. HOPEFUL.—A baker fixes the price of a quartern loaf, when the cost of converting wheat into bread is 5 per cent. on the cost of the wheat, with a view to gaining 20 per cent. on the cost of his bread. Show that if wheat falls 16 per cent., and the cost of converting it into bread rises 20 per cent., he ought to sell seven loaves for the price at which he before sold six, and that if he does not alter his price, he will gain on his outlay 40 per cent. instead of 20 per cent.

Cost of converting the wheat into bread in the first case = $\frac{5}{105}$, or $\frac{1}{21}$ of original cost of wheat ;

∴ Cost-price of bread in first case $= \frac{21}{20}$ of original cost of wheat;

Selling " " " $= \left(\frac{21}{20} \times \frac{\cancel{20}^{3}}{\cancel{20}\cancel{0}_{50}}\right)$ " "

$= \frac{63}{50}$ " " ;

Cost of converting the wheat into bread in the second case

$= \left(\frac{1}{20} \times \frac{\cancel{20}^{3}}{\cancel{20}\cancel{0}_{50}}\right)$ of original cost of wheat

$= \frac{3}{50}$ " " " ;

∴ Cost-price of bread in second case

$= \left(\frac{100-16}{100} + \frac{3}{50}\right)$ of original cost of wheat

$= \frac{42+3}{50}$ " " "

$= \frac{9}{10}$ " " " ;

∴ Price of loaf in first case : Price of loaf in second case

:: $\frac{21}{20}$: $\frac{9}{10}$,

:: 21 : 18,

:: 7 : 6;

∴ He ought to sell seven loaves for the price at which he before sold six.

Gain in second case if selling-price is unaltered

$= (\frac{63}{50} - \frac{9}{10})$ of original cost of wheat

$= \frac{63-45}{50}$ " " "

$= \frac{9}{25}$ " " " ;

∴ $\frac{9}{10}$: 100 :: $\frac{9}{25}$: Gain per cent.

∴ Gain per cent. $= \frac{\cancel{20}^{4}}{1} \times \frac{g}{\cancel{g}} \times \frac{10}{\cancel{g}}$

$= 40.$

15. SPES.—The paper duty was $1\frac{1}{2}$d. per lb.; the duty on playing cards 1s. per pack. Three packs of playing-cards weigh 1 lb. The paper manufacturer gains 20 per cent. on his outlay; the maker of the cards 20 per cent. on his sale. The former duty has been abolished, and the latter reduced to 3d. Show that the price of cards might be reduced 1s. a pack, allowing each tradesman the same rate of profit as before.

Paper duty on a pack of cards was $\frac{1}{2}$d.

Cost for duty to maker of cards $= 1s. + \left(\frac{1}{2}d. \times \frac{\cancel{12}^{6}}{\cancel{20}\cancel{0}_{5}}\right)$

$= 1s. + \frac{3}{5}d.$

$= 12\frac{3}{5}d.$;

" " buyer " $= 12\frac{3}{5}d. \times \frac{100}{100-20}$

$= \left(\frac{63}{5} \times \frac{\cancel{20}^{5}}{\cancel{8}\cancel{0}_{4}}\right)d.$

$= 15\frac{3}{4}d.$;

Cost for duty to buyer of cards after reduction

$= 3d. \times \frac{100}{80}$

$= \frac{15}{4}d.$

$= 3\frac{3}{4}d.$;

∴ Difference between the two prices $= 15\frac{3}{4}d. - 3\frac{3}{4}d.$

$= 1s.$

Geometry.

1. SUDBURY.—ABC is a triangle, and the exterior angles at B and C are bisected by the straight lines BD, CD respectively, meeting at D; show that the angle BDC together with half the angle BAC make up a right angle. (*Todhunter.*)

Produce AB to any point F, and AC to any point G. Bisect angles CBF, BCG by the straight lines BD, CD, meeting at D.

Bisect the angles ABC, ACB by the straight lines BE, CE, meeting at E.

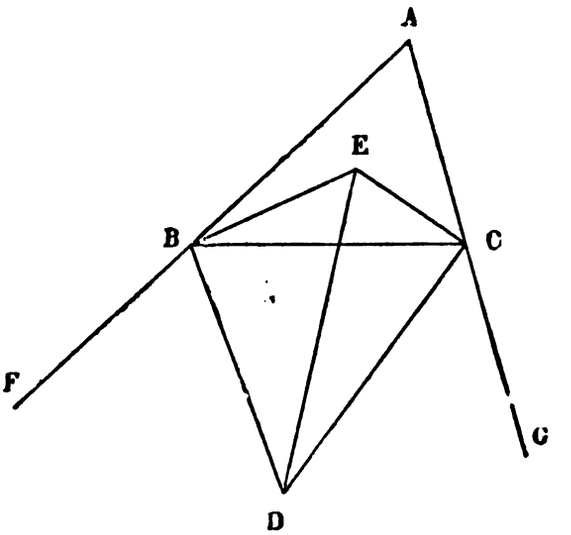
Join ED.

Proof.— ∠ EBC = Half ∠ ABC,

∠ DBC = " ∠ FBC,

∴ ∠ EBD = " ∠ sABC, FBC

= half of 2 right angles; (I. 13.)



Wherefore ∠ EBD is a right angle;

Similarly it can be proved that ∠ ECD is a right angle.

Again, ∠ sBEC, EBC, ECB = 2 right angles, (I. 32.)

∴ ∠ BEC together with $\frac{1}{2}$∠ ABC and $\frac{1}{2}$∠ ACB = 2 right angles;

∠ EBD is a right angle,

∴ ∠ sBED, EDB = a right angle (I. 32.)

Wherefore ∠ sBEC, BDC are together equal to two right angles;

∴ ∠ sBEC, BDC = ∠ sBEC, $\frac{1}{2}$∠ ABC, $\frac{1}{2}$∠ ACB,

Wherefore, ∠ BDC = $\frac{1}{2}$∠ ABC, $\frac{1}{2}$∠ ACB,

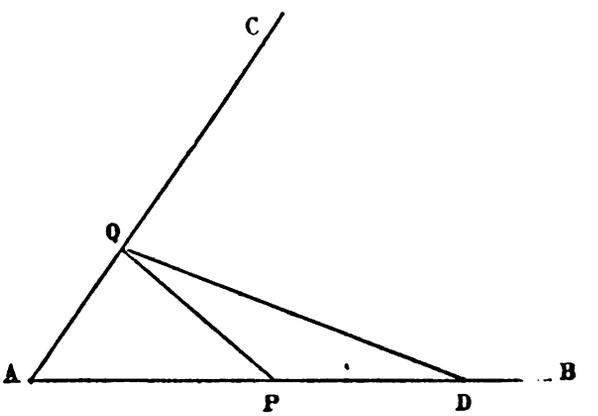
Add $\frac{1}{2}$∠ BAC to each;

∴ ∠ BDC + $\frac{1}{2}$∠ BAC = $\frac{1}{2}$∠ ABC, $\frac{1}{2}$∠ ACB, $\frac{1}{2}$∠ BAC

= $\frac{1}{2}$ of two right angles

= a right angle. Q. E. D.

2. BONA FIDE.—AB, AC, are two straight lines given in position; it is required to find in them two points P and Q, such that, PQ being joined, AP and PQ may together be equal to a given straight line, and may contain an angle equal to a given angle. (*Todhunter.*)



From AB cut off AD equal to the given straight line. (I. 3.)

At the point D draw DQ making the angle ADQ equal to half the given angle, and meeting AC in Q.

At the point Q draw QP, on the same side of QD as DA, making the angle QPD equal to the angle QDP, and meeting AB in P.

Proof.— ∠ PDQ = ∠ PQD (Con.)

∴ PQ = PD; (I. 6.)

Wherefore AP and PQ = AD

= the given straight line.

Again, $\angle APQ = \angle$ sPQD, PDQ (I. 32.)
$= $ Twice $\angle PDQ$
$= $ Given angle. Q. E. F.

Note.—We believe paragraph A would obtain most marks.

3. BOLDMERE.—Show how to divide a straight line into two parts, such that the rectangle under the whole line and one of the parts shall be equal to the square on the other part.

Show from the construction that the parts of the divided line are to each other as $\sqrt{5}-1$ to $3-\sqrt{5}$. What is the simplest form of this ratio? (*2nd Stage Mathematics*, 1884.)

Let AB contain a linear units;

Then $AC = a$, and $AE = \frac{a}{2}$;

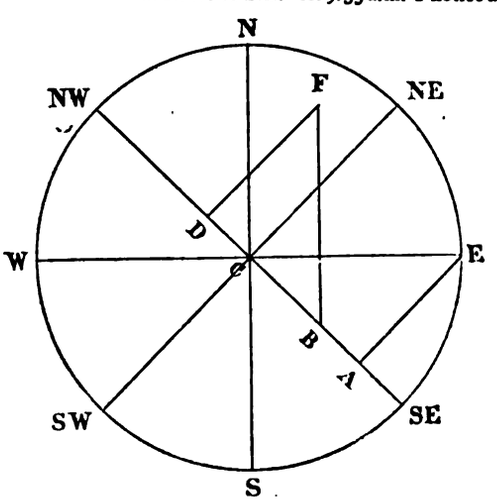
$$EB^2 = AB^2 + AE^2$$
$$= a^2 + \left(\frac{a}{2}\right)^2$$
$$= a^2 + \frac{a^2}{4}$$
$$= \frac{5a^2}{4}$$
$$\therefore EB = \frac{a\sqrt{5}}{2};$$
$$EF = EB = \frac{a\sqrt{5}}{2};$$
$$AF = EF - AE$$
$$= \frac{a\sqrt{5}}{2} - \frac{a}{2}$$
$$= \frac{a(\sqrt{5}-1)}{2}$$

But $AH = AF = \frac{a(\sqrt{5}-1)}{2}$;

$$HB = AB - AH$$
$$= a - \frac{a(\sqrt{5}-1)}{2}$$
$$= \frac{2a - a\sqrt{5} + a}{2}$$
$$= \frac{a(3-\sqrt{5})}{2};$$
$$\therefore AH : HB :: \frac{a(\sqrt{5}-1)}{2} : \frac{a(3-\sqrt{5})}{2},$$
$$:: \sqrt{5}-1 : 3-\sqrt{5},$$
$$:: (\sqrt{5}-1)(\sqrt{5}+1) : (3-\sqrt{5})(\sqrt{5}+1),$$
$$:: (5-1) : 2\sqrt{5}-2,$$
$$:: 4 : 2(\sqrt{5}-1),$$
$$:: 2 : \sqrt{5}-1.$$

Note.—Perhaps full percentage of marks for your writing.

4. CASSIVELLAUNUS.—I am walking along a straight beach which stretches from N.W. to S.E. At 9.35 a.m. I notice a black



buoy to the N.E. At 9.43 a.m. I see a red buoy due N. of me. At 10 a.m. the black buoy is due E. of me, and at 10.8 a.m. I see the red buoy to the N.E. Compare the distances of the buoys from the shore, I having walked all the time at the same rate.

Let A be my position at 9.35 a.m., B at 9.43 a.m., C at 10 a.m., and D at 10.8 a.m. Draw AE parallel to the line to the N.E., BF parallel to the line to the N., and DF parallel to the line to the N.E.

Then, E denotes the position of the black buoy, and F the position of the red buoy.

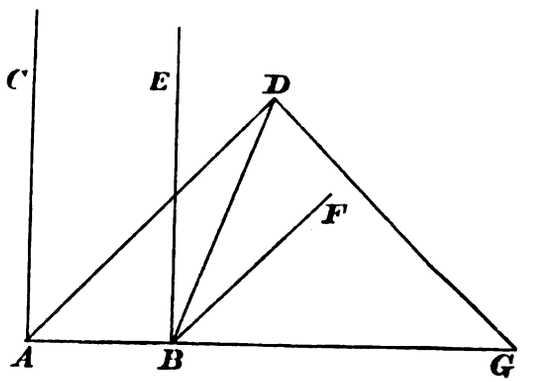
AC represents distance walked from 9.35 a.m. to 10 a.m., that is, in 25 minutes;

BD represents the distance walked from 9.43 a.m. to 10.8 a.m., that is, in 25 minutes;

$\therefore AC = BD.$

In the triangles AEC, DFB,
$\angle EAC = \angle FDB$, (Ax. 11.)
And $\angle ECA = \angle FBD$,
As $\angle ECA = \frac{1}{8}$ Right Angle,
And $\angle FBD = \angle$ between the lines to the N. and N.W.
$= \frac{1}{8}$ Right Angle;
And side AC = side BD;
$\therefore$ side AE = side DF. (I.26.)
Therefore the buoys are at the same distance from the shore.

5. CORWISI.—Produce a given straight line so that the square on the whole line thus produced may be double the square on the part produced.



Let AB be the given straight line.

At A draw AC at right angles to AB, and bisect the angle BAC by the straight line AD.

Draw BE parallel to AC, and BF parallel to AD.

Bisect the angle EBF by the straight line BD, meeting AD in D.

At the point D draw DG at right angles to AD, meeting AB produced in G.

Then the square on AG shall be double the square on BG.

Proof.— $\angle EBG$ is a right angle,
and $\angle EBD$ is $\frac{1}{2}$ of a right angle,
$\therefore \angle DBG$ is $\frac{1}{2}$ " " " ;
$\angle DBG = \angle$s BAD, ADB, (I. 32.)
and $\angle BAD$ is $\frac{1}{2}$ of a right angle,
$\therefore \angle ABD$ is $\frac{1}{4}$ " " " ;
$\angle ADG$ is a right angle,
$\therefore \angle BDG$ is $\frac{3}{4}$ of a right angle;
Wherefore BG = DG. (I. 6.)
Again, $\angle ADG$ is a right angle,
and $\angle DAG$ is $\frac{1}{2}$ of a right angle,
$\therefore \angle DGA$ is $\frac{1}{2}$ " " " ; (I. 32.)
Wherefore AD = DG.
$AG^2 = AD^2 + DG^2$, (I. 47.)
$= 2DG^2$
$= 2BG^2$. Q. E. F.

Note.—Each correspondent is restricted to *one* question. Please send the arithmetical query you wish to be solved next month and the answer.

Mensuration.

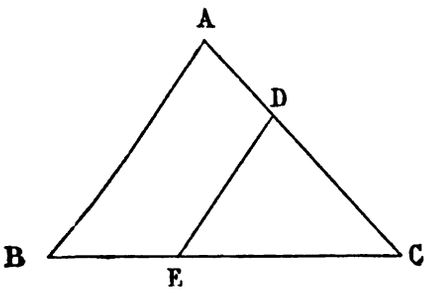
1. E. COUMBE.—The external length, breadth, and height of a rectangular wooden closed box are 18, 10, and 6 in. respectively, and the thickness of the wood is $\frac{1}{2}$ in. When the box is empty it weighs 15 lbs., and when filled with sand 100 lbs. Compare weights of equal bulks of wood and sand. (*Brook Smith.*)

Weight of box $= [(18 \times 10 \times \frac{1}{2} \times 2) + \{18 \times (6-1) \times \frac{1}{2} \times 2\} + \{(10-1) \times (6-1) \times \frac{1}{2} \times 2\}]$ cub. in.
$= (180+90+45)$ cub. in.
$= 315$ cub. in. ;

Internal content of box $= \{(18-1) \times (10-1) \times (6-1)\}$ cub. in.
$= (17 \times 9 \times 5)$ cub. in.
$= 765$ cub. in.;

$\therefore$ Wood : Sand :: $\left(\frac{\cancel{7}\cancel{8}}{\cancel{3}\cancel{1}\cancel{8}} \times \frac{255}{2\cancel{1}}\right)$ lbs. : $(100-15)$ lbs.
$:: \frac{255}{7} : 85,$
$:: \frac{3}{7} : 1,$
$:: 3 : 7.$

2. POMPEY.—The side AB of a triangular field is 40, BC 30, and CA 25 chains. Required the size of the sides of a triangle parted off by a division fence made parallel to AB, and proceeding from a point in CA at the distance of 9 chains from the angle A.



$CD = CA - AD$
$= (25-9)$ chains
$= 16$ chains ;

$CE : CB :: CD : CA,$
$CE : 30 :: 16 : 25,$

$\therefore CE = \frac{\cancel{3}\cancel{0} \times 16}{\cancel{2}\cancel{5}}$ chains
$= \frac{96}{5}$ chains
$= 19{\cdot}2$ chains ;

$DE : AB :: CD : CA,$
$DE : 40 :: 16 : 25,$

$\therefore DE = \frac{\cancel{4}\cancel{0} \times 16}{\cancel{2}\cancel{5}}$ chains
$= \frac{128}{5}$ chains
$= 25{\cdot}6$ chains.

3. F. G. JACKSON.—A garden is 100 ft. long and 80 ft. broad. A walk of equal width is made all round it ; find the width, so that it takes up just half the ground.

Area of walk $= \frac{100 \times 80}{2}$ sq. ft.
$= 4000$ sq. ft ;

But, area of walk $= [2(100+80 - \text{twice width}) \times \text{width}]$ sq. ft.
$= \{(360 - 4 \text{ times width}) \times \text{width}\}$ sq. ft.
$= (360 \text{ times width} - 4 \text{ times width}^2)$ sq. ft. ;

$\therefore$ 360 times width $- 4$ times width$^2 = 4000$
4 times width$^2 - 360$ times width $= -4000$
Width$^2 - 90$ times width $= -1000$
Width$^2 - 90$ times width $+ (45)^2 = 2025 - 1000 = 1025$
Width $- 45 = \pm 32{\cdot}01562\ldots$
$\therefore$ Width $= \pm 32{\cdot}01562\ldots + 45$
$= 77{\cdot}01562\ldots$, or $12{\cdot}9843\ldots$

It is evident that the value $77{\cdot}01562\ldots$ is inapplicable.
$\therefore$ Width of walk $= 12{\cdot}9843\ldots$ ft.

Note.—See No. 9 (Arithmetic) in our issue for February, 1884, for the other query.

4. M. R. S.—A rectangular parish 6 fur. long and 4 fur. broad is enclosed ; a belt of plantation 200 feet wide is carried the whole way round ; a main road 60 feet wide runs across the land in the direction of its length, and a cross road 41 feet wide in the direction of its breadth ; how many acres of field were there? (*Colenso.*)

There are four equal rectangular parts of field, the dimensions of which are
$[(6 \times 220)$ yds. $- \{(200 \times 2) + 41\}$ ft.$] \div 2$, and
$[(4 \times 220)$ yds. $- \{(200 \times 2) + 60\}$ ft.$] \div 2$;

$\therefore$ Part field $= \frac{1320 - 147}{2}$ yds. $\times \frac{880 - 41\cancel{8}}{2}$ yds. $\times 4$
$= \left(\frac{\cancel{3}\cancel{9}\cancel{1}}{\cancel{2}} \times \frac{1090}{\cancel{3}} \times \frac{\cancel{4}}{1}\right)$ sq. yds.
$= 852{,}380$ sq. yds.
$= 176$ ac. 540 sq. yds. Ans.

General.

1. J. P.—'Epochs of English History' (Longmans and Co.) ; 'Modern England,' and the preceding volume 1s. each. 'The Nineteenth Century,' by *Mackenzie* (Nelson); Abridgment of 'History of our Own Times,' by *J. McCarthy*, 6s. (Chatto and Windus.)

2. R. ALLEN.—80.

3. HUNTINGDON :—

Sentence.	Kind.	Con. nec- tive.	Subject.	Predi- cate.	Ob- ject.	Extension.
(*a*) They stood aloof, the scars remaining like cliffs	P. S.		they	stood		aloof, the scars remaining like cliffs (man.)
(*b*) Which had been rent asunder	Adj. to *cliffs* in *a*	*Inrel. pro.*	which	had been rent		asunder
(*c*) A dreary sea now flows between	P.S.		A dreary sea	flows		between (place) now (time)
(*d*) But I ween	P.S. Adv. to *c*	but	I	we:n		
(*e*) Neither heat shall wholly do away the marks of that	Noun sent. to *d*	neither	heat	shall do- away = destroy	the marks of that	wholly (deg.)
(*f*) Nor frost	*do.*	nor	frost	[shall do, etc.]	,,	
(*g*) Nor thunder	*do.*	nor	thunder	[shall do, etc.]	,,	
(*h*) Which hath been once.	Adj. sent. to *that* in *e*		which	hath been		once

4. EMERALD.—The two expressions do *not* coincide.

5. IMPORTUNATE.—The solution of your query appeared in our issue for June, 1883.

6. PUZZLED.—You will find the solution of your query in our issue for April, 1882.

7. X. Y. Z.—Your query was solved in our issue for February, 1882.

8. FRED.—If the well be bell-shaped, the depth at which the sides diverge must be given, otherwise the solidity cannot be ascertained. The volumes of the cylinder and the frustrum of the cone could then be found.

Volume of cylinder $= a^2 h$;

,, frustrum of cone $= \frac{h}{3}(a^2 + ab + b^2)$;

where, a^2 and b^2 are the areas of the two ends, and h is the height.

9. D. V.—*Dickinson's* 'History of the English Language,' price 3d. (Hughes).

10. GUV'NOR.—70.

11. FELIX.—Apply for permission to sit, and if your inspector recommends you, you will receive notice when to attend. Writing, 80 per cent.

12. PICCIOLA.—A sort of translation is published by Warne and Co. Writing is good; small hand especially. 90.

13. W. E. MILTON.—Hour, honour, heir, honesty, hostler, and their derivatives. Twenty one thousand four hundred and eight millions, etc., is the safest way to write it; the meaning of the word billion is not settled.

14. DAUNTLESS.—Yes.

15. LUDWIG.—(*a*) Thick, badly formed letters; (*b*) not quite so thick and a little better formed, both very moderate. (*a*) 50, (*b*) 55. The book you name is not bad; we should prefer *Smith's*, Part I., or *Macmillan's* Progressive Course.

16. ROBERT STEPHENSON.—See any of the 'Guides to the Civil Service.' The writing is wretched, and could hardly be worse for the purpose you name.

17. MARMER.—The copying is clear and neat. The writing shows promise, and with practice may develop into a capital hand. The chief fault is want of finish; the letters are often rough and uneven, and the curves badly formed.

18. H. N. W.—

Sentence.	Kind of Sentence.	Conn.	Subject.	Predicate.	Object.	Ext. of Pred.
(*a*) He spake	Princ. S.		He	spake		
(*b*) and Enid easily believed	Princ. S. *co-ord. with* (*a*)	and	Enid	believed		easily like
(*c*) Simple, noble natures, credulous of (that) (believe)	Adv. Sent. to (*b*)		simple, noble natures credulous of (that)	(believe)		
(*d*) they long for what, good in friend or foe, there most in those	Adj. Sent. to (*c*)		they	long-for	what, good in friend or foe there most in those	
(*e*) who most have done them ill	Adj. Sent. to (*d*)		who	have done	them ill	most

—Writing legible, down strokes rough and uneven, curves need special attention.

19. R. R. P.—The large hand is good. In the small hand the letters and the strokes should conform to the general usage. The words are short, and consist of nearly the same letters. See rules for the Query Column.

20. AGGIE.—The writing is poor, but it is better than the composition. Get a good copy-book and practise.

21. L. D. C.—75.

22. CICERO.—Bold, legible, and promising; careful imitation of a few good copies would improve it.

23. CIVIL SERVICE INQUIRER.—Repeat your question, and say where it can be found. What you have written this time was certainly never set anywhere by anybody; it is unintelligible and ungrammatical.

24. MATRICULATION.—If you take Second Year's Papers and pass in the first class you may succeed. Take two years. Write again after Christmas.

25. A REGULAR SUBSCRIBER.—The name is W. G. Rushbrooke. The book is *printed* at the Clarendon Press, Oxford, and *published* for the university by Macmillan and Co. Refer to the end of your book.

26. FLOWER.—

Sentence.	Kind of Sentence.	Subject.	Predicate.	Object.	Exten.
(*a*) Thou count life a stage upon thy way	Princ. S.	Thou	count	life a stage upon thy way (*factitive* obj.)	
(*b*) Thou follow conscience	Princ. S. *co ord.* with (*a*)	(thou)	follow	conscience	
(*c*) what may come	Adj. Sen. to (*d*)	which	may (come)		
(*d*) Although it come	Adv. S.	that	should come	it	
(*e*) (thou) fear God	Princ. S.	Thou alike with heaven and earth, sincere, with hand, and brow, and bosom clear, with	fear	God	
(*f*) know no other fear	Princ. S.	(Thou)	know	no other fear	

27. J. W. KING, Harrogate.—(1) No. You will be quite safe in using the questions.

(2) Don't use the words of an author who has not been dead forty years without written permission. Insert the name of author at the end of each extract.

28. J. EMERY.—(1) Your query in Algebra was solved in our issue for June, 1884.

(2) Examples:—Pharaoh dreamed a dream. He ran a race. They fought a good fight. (They are called the Cognate Objective.)

(3) Perhaps full marks. It is rather *too thick*.

29. P. T.—(1) To find Principal:—

Simple Proportion.

Amount of £100 for the given time at the given rate per cent. : Given Amount :: £100 : Principal.

(2) To find Rate Per Cent.:—

Compound Proportion.

£
Principal : 100
year
Given time : 1
:: Interest : Rate per cent.

(3) To find Time:—

Simple Proportion.

Interest on Principal for 1 year : Total Interest :: 1 year : Time.

30. H. MEAD.—(1) Thanks for your communication.

(2) The answer to O. 5. in Ex. 62 should be £179 18s. $5\frac{1}{2}$d.

(3) The answer to E. 2. in Ex. 67 should be $121\frac{2}{3}$ lbs.

(4) Ex. 97, C. 3. Any two decimals whose difference is ·25 satisfy the condition, as ·25 + (·025 × 2) = ·3. The question is, therefore, incorrect.

31 CORRESPONDENT.—The fifth, seventh, and any other roots of numbers can be easily determined by Logarithms.

32. SCIENCE.—A railway truck weighs 12 tons; it is drawn from rest by a horse through a distance of 50 feet, and is then

moving at the rate of 3 miles per hour; if the resistances are 8 lbs. per ton, how many units of work must the horse have done on the truck?

No. of units of work done by the horse

$$= \left\{ \frac{\text{Weight of truck in lbs.}}{2g} \times (\text{Velocity per sec. in ft.})^2 \right\} + (\text{Resistance per ton} \times \text{No. of tons} \times \text{Space in ft.})$$

$$= \left\{ \frac{\cancel{2}\,\cancel{2}\,\cancel{4} \times 20 \times 112}{\cancel{2} \times \cancel{g}\,\cancel{3}\cdot\cancel{2}\,\cancel{g}} \times \left(\frac{\cancel{3} \times \cancel{5}\,\cancel{2}\,\cancel{8}\,\cancel{4}}{\cancel{8}\,\cancel{8} \times \cancel{8}\,\cancel{8}} \right)^2 \right\} + (8 \times 12 \times 50)$$

$$= \left\{ \frac{4480}{10\cdot73} \times \left(\tfrac{22}{5}\right)^2 \right\} + 4{,}800$$

$$= \frac{896 \times 484}{10\cdot73 \times 5} + 4{,}800$$

$$= \frac{433664}{53\cdot65} + 4{,}800$$

$$= 8{,}083 + 4{,}800$$

$$= \underline{12{,}883.} \quad \text{Ans.}$$

33.—A TEACHER.—Managers have a limited right, but the Education Department is the sole judge of the reasonableness of the dismissal. The grant may be endangered if children are improperly excluded from school, but any fair case would undoubtedly be upheld by the Department.

Algebra.

1. PRIAM.—Solve:—

(1) $\dfrac{x+\sqrt{12a^2-x}}{x-\sqrt{12a^2-x}} = \dfrac{a+1}{a-1}$.

(2) $x^3+3ax^2=4a^3$.

(3) $\dfrac{x+\sqrt{x^2-1}}{x-\sqrt{x^2-1}} - \dfrac{x-\sqrt{x^2-1}}{x+\sqrt{x^2-1}} = 8\sqrt{x^2-1}$.

(*Todhunter's* 'Algebra for Beginners.')

(1) $\dfrac{x+\sqrt{12a^2-x}}{x-\sqrt{12a^2-x}} = \dfrac{a+1}{a-1}$

Numerator − Denominator ;
Numerator + Denominator

$$\therefore \frac{2\sqrt{12a^2-x}}{2x} = \frac{2}{2a}$$

$$\frac{\sqrt{12a^2-x}}{x} = \frac{1}{a}$$

$$12a^2 - x = \frac{x^2}{a^2}$$

$$\frac{x^2}{a^2} + x = 12a^2$$

$$x^2 + a^2x = 12a^4$$

$$x^2 + a^2x + \left(\frac{a^2}{2}\right)^2 = 12a^4 + \frac{a^4}{4}$$

$$= \frac{49a^4}{4}$$

$$x + \frac{a^2}{2} = \pm\frac{7a^2}{2}$$

$$x = \pm\frac{7a^2}{2} - \frac{a^2}{2}$$

$$x = 3a^2, \text{ or } -4a^2;$$

The minus value does not satisfy the equation.

$$\therefore \underline{x = 3a^2.}$$

(2) $x^3+3ax^2=4a^3$

$$x^3 - a^3 = 3a^3 - 3ax^2$$

$$= 3a(a^2 - x^2)$$

$$= -3a(x^2 - a^2)$$

Dividing by $(x-a)$;

$$\therefore x^2 + ax + a^2 = -3a(x+a)$$

$$= -3ax - 3a^2$$

$$x^2 + 4ax + 4a^2 = 0$$

Extracting square root, $x + 2a = 0$

$$\therefore \underline{x = -2a.}$$

As we divided by $x-a$, therefore a is one value of x;

$$\therefore \underline{x = a, \text{ or } -2a.}$$

(3) $\dfrac{x+\sqrt{x^2-1}}{x-\sqrt{x^2-1}} - \dfrac{x-\sqrt{x^2-1}}{x+\sqrt{x^2-1}} = 8\sqrt{x^2-1}$

$$\frac{(x+\sqrt{x^2-1})^2 - (x-\sqrt{x^2-1})^2}{(x-\sqrt{x^2-1})(x+\sqrt{x^2-1})} = 8\sqrt{x^2-1}$$

$$\frac{x^2 + 2x\sqrt{x^2-1} + x^2 - 1 - (x^2 - 2x\sqrt{x^2-1} + x^2 - 1)}{x^2 - (x^2-1)} = 8\sqrt{x^2-1}$$

$$\frac{2x^2 - 1 + 2x\sqrt{x^2-1} - 2x^2 + 1 + 2x\sqrt{x^2-1}}{x^2 - x^2 + 1} = 8\sqrt{x^2-1}$$

$$4x\sqrt{x^2-1} = 8\sqrt{x^2-1}$$

Dividing by $\sqrt{x^2-1}$;

$$4x = 8$$

$$\therefore \underline{x = 2.}$$

As we divided by $\sqrt{x^2-1}$, therefore $x^2 = 1$; wherefore $x = \pm 1$.

$$\therefore \underline{x = 2, \text{ or } \pm 1.}$$

2. VIRGIL.—Solve:

(1) $a^2x^2 - 2a^3x + a^4 - 1 = 0$.

(2) $4a^2x = (a^2 - b^2 + x)^2$.

(*Todhunter's* 'Algebra for Beginners.')

(1) $a^2x^2 - 2a^3x + a^4 - 1 = 0$

$$a^2x^2 - 2a^3x + a^4 = 1$$

$$x^2 - 2ax + a^2 = \frac{1}{a^4}$$

Extracting square root;

$$x - a = \pm\frac{1}{a}$$

$$\therefore \underline{x = a \pm \frac{1}{a}}$$

(2) $4a^2x = (a^2 - b^2 + x)^2$

$$= a^4 + b^4 + x^2 - 2a^2b^2 + 2a^2x - 2b^2x$$

$$-x^2 + 4a^2x - 2a^2x + 2b^2x = a^4 - 2a^2b^2 + b^4$$

$$x^2 - 2a^2x - 2b^2x = -(a^4 - 2a^2b^2 + b^4)$$

$$x^2 - 2(a^2 + b^2)x = -(a^4 - 2a^2b^2 + b^4)$$

$$x^2 - 2(a^2 + b^2)x + (a^2 + b^2)^2 = a^4 + 2a^2b^2 + b^4 - a^4 + 2a^2b^2 - b^4$$

$$= 4a^2b^2$$

$$x - (a^2 + b^2) = \pm 2ab$$

$$x = a^2 \pm 2ab + b^2$$

$$\therefore \underline{x = (a \pm b)^2.}$$

3. SUBSCRIBER.—One side of a triangle is half the sum of the two others; the sum of the three sides is 84 feet, and the area of the triangle is 14 square yards; find its sides.

Sum of sides = 28 yds.;
One side = ½ sum of the two other sides
= ¼ ,, three sides
= $\frac{28}{4}$ yds.;
Sum of two other sides = ¾ of 28 yds.
= $\frac{84}{4}$ yds.;
Let x = one of the other sides in yds.,
Then, $\frac{84}{4} - x$ = the third side in yds.;
Half sum of sides = 14 yds.;

$$\therefore \sqrt{14 \times (14 - \tfrac{28}{2}) \times (14 - x) \times \{14 - (\tfrac{84}{4} - x)\}} = 14$$

$$\sqrt{14 \times \tfrac{14}{3} \times (14 - x) \times \frac{3x - 14}{3}} = 14$$

$$14\sqrt{\frac{14 - x}{3} \times \frac{3x - 14}{3}} = 14$$

$$\sqrt{\frac{56x - 3x^2 - 196}{9}} = 1$$

$$56x - 3x^2 - 196 = 9$$

$$3x^2 - 56x = -205$$

$$x^2 - \frac{56x}{3} = -\frac{205}{3}$$

$$x^2 - \frac{56x}{3} + (\tfrac{28}{3})^2 = \tfrac{784}{9} - \tfrac{205}{3}$$

$$= \frac{784 - 615}{9}$$

$$= \tfrac{169}{9}$$

$$x - \tfrac{28}{3} = \pm\tfrac{13}{3}$$

$$x = \pm\tfrac{13}{3} + \tfrac{28}{3}$$

$$\therefore \underline{x = \tfrac{41}{3}, \text{ or } 5.}$$

$\therefore$ Sides of triangle are $9\frac{1}{3}$ yds., $13\frac{2}{3}$ yds., and 5 yds.

4. SOLICITOR.—Out of 12 consonants and 5 vowels, how many words can be formed each containing 6 consonants and 3 vowels?

Out of 12 consonants we get

$\frac{12\times11\times10\times9\times8\times7}{\lfloor 6}$ combinations of 6 consonants;

Out of 5 vowels we get

$\frac{5\times4\times3}{\lfloor 3}$ combinations of 3 vowels;

$\therefore$ We get $\frac{12\times11\times10\times9\times8\times7}{\lfloor 6}\times\frac{5\times4\times3}{\lfloor 3}$ combinations of 6 consonants and 3 vowels;

Each combination gives rise to $\lfloor 9$ permutations;

$\therefore$ We get $\frac{12\times11\times10\times9\times8\times7}{\lfloor 6}\times\frac{5\times4\times3}{\lfloor 3}\times\lfloor 9$ words

$=3,353,011,200$ words. Ans.

5. W. TAYLOR.—Solve:—

$$\frac{6}{x-1}+\frac{8}{x-5}=\frac{7}{x+1}+\frac{18}{x+5}.$$

(*Todhunter's* 'Algebra for Beginners.')

$$\frac{6}{x-1}+\frac{8}{x-5}=\frac{7}{x+1}+\frac{18}{x+5}$$

$$\frac{6}{x-1}-\frac{7}{x+1}=\frac{18}{x+5}-\frac{8}{x-5}$$

$$\frac{6x+6-7x+7}{x^2-1}=\frac{18x-90-8x-40}{x^2-25}$$

$$\frac{-x+13}{x^2-1}=\frac{10x-130}{x^2-25}$$

$$-\frac{x-13}{x^2-1}=\frac{10(x-13)}{x^2-25}$$

Dividing by $(x-13)$:

$$-\frac{1}{x^2-1}=\frac{10}{x^2-25}$$

$$-x^2+25=10x^2-10$$

$$-x^2-10x^2=-10-25$$

$$11x^2=35$$

$$x^2=\tfrac{35}{11}$$

$$\therefore\ x=\pm\sqrt{\tfrac{35}{11}}.$$

As we divided by $x-13$, therefore 13 is one value of x.

$$\therefore\ x=13,\text{ or }\pm\sqrt{\tfrac{35}{11}}.$$

6. R. H. L.—Given $\log_{10}2=\cdot301030$, and $\log_{10}7=\cdot845098$, find the logarithm of $(\frac{2}{343})^{\frac{1}{3}}$ to the base 1000. (*Todhunter.*)

Logarithm to the base 10.

$$\text{Log}\,(\tfrac{2}{343})^{\frac{1}{3}}=\tfrac{1}{3}\log(\tfrac{2}{343})$$

$$=\tfrac{1}{3}\log\left(\frac{2^3}{7^3}\right)$$

$$=\tfrac{1}{3}\log(2^3-7^3)$$

$$=\log 2-\tfrac{3}{3}\log 7$$

$$=\cdot301030-(\cdot845098\times\tfrac{3}{3})$$

$$=\cdot301030-1\cdot267647$$

$$=-\cdot966617$$

Logarithm to the base 1000.

$$\text{Log}\,(\tfrac{2}{343})^{\frac{1}{3}}=-\cdot966617\times\frac{1}{\log_{10}1000}$$

$$=-\cdot966617\times\tfrac{1}{3}$$

$$=-\cdot322205.$$

7. YELDIR GONL.—A, B, and C are three brothers. Ten years ago A's age was twice B's; eight years ago B's was twice C's; and two years ago A's was twice C's. When did A come of age? (*College of Preceptors*, Midsummer, 1884.)

Let x=A's present age,

" y=B's " ,

And " z=C's " ;

Then

$$\left.\begin{array}{l}(1)\ x-10=2(y-10)\\(2)\ y-8=2(z-8)\\(3)\ x-2=2(z-2)\end{array}\right\}$$

$$\left.\begin{array}{l}(1)\ x-2y=-10\\(2)\ y-2z=-8\\(3)\ x-2z=-2\end{array}\right\}$$

$$\left.\begin{array}{l}(2)\ y-2z=-8\\(3)\ x-2z=-2\end{array}\right\}$$

Subtracting, $-x+y=-6$

$$\left.\begin{array}{l}2x-2y=12\\(1)\ x-2y=-10\end{array}\right\}$$

Subtracting, $\therefore\ x=22.$

$\therefore$ A came of age a year ago.

Note.—Each correspondent is restricted to *one* question.

8. ST. AUBIN.—Solve:—

$$x\left\{1+\left(\frac{a}{x}\right)^{\frac{2}{3}}\right\}^2=b\left(\frac{a}{x}\right)^{\frac{1}{3}}.$$

$$x\left\{1+\left(\frac{a}{x}\right)^{\frac{2}{3}}\right\}^2=b\left(\frac{a}{x}\right)^{\frac{1}{3}}$$

$$=\frac{a^{\frac{1}{3}}b}{x^{\frac{1}{3}}}$$

Multiplying each side by $x^{\frac{1}{3}}$:

$$x^{\frac{4}{3}}\left\{1+\left(\frac{a}{x}\right)^{\frac{2}{3}}\right\}^2=a^{\frac{1}{3}}b$$

Extracting square root of each side:

$$x^{\frac{2}{3}}\left\{1+\left(\frac{a}{x}\right)^{\frac{2}{3}}\right\}=a^{\frac{1}{6}}b^{\frac{1}{2}}$$

$$x^{\frac{2}{3}}+a^{\frac{2}{3}}=a^{\frac{1}{6}}b^{\frac{1}{2}}$$

$$x^{\frac{2}{3}}=a^{\frac{1}{6}}b^{\frac{1}{2}}-a^{\frac{2}{3}}$$

$$x^2=\left(a^{\frac{1}{6}}b^{\frac{1}{2}}-a^{\frac{2}{3}}\right)^3$$

$$\therefore\ x=\pm\sqrt{\left(a^{\frac{1}{6}}b^{\frac{1}{2}}-a^{\frac{2}{3}}\right)^3}.$$

9. ESSAVIST.—A quantity of corn is to be divided among n persons, and is calculated to last a certain time, if each of them receive a peck every week; during the distribution it is found that one person dies every week, and then the corn lasts twice as long as was expected. Find the quantity of corn, and the time it was expected to last.

Let x=Time the corn was expected to last in weeks;

Then, nx=Quantity of corn in pecks;

We have an Arithmetical Progression, in which the first term is n, the difference -1, the no. of terms $2x$, and the sum nx.

$$S=\{2a+(n-1)d\}\frac{n}{2}$$

$$\therefore\ nx=[2n+\{(2x-1)\times-1\}]\times\frac{2x}{2}$$

$$=(2n-2x+1)\times x$$

Dividing each side by x,

$$n=2n-2x+1$$

$$2x=2n-n+1$$

$$=n+1$$

$$\therefore\ x=\frac{n+1}{2}.$$

$\therefore$ The corn was expected to last $\frac{n+1}{2}$ weeks;

The quantity of corn was $\frac{n(n+1)}{2}$ pecks.

Note.—No.

10. BLACKBIRD.—In a geometrical progression of 5 terms the difference of the extremes is to the difference of the 2nd and 4th terms as 10 : 3, and the sum of the 2nd and 4th terms equals twice the product of the 1st and 2nd. Find the series.

(1)

$$ar^4-a : ar^3-ar :: 10 : 3,$$

$$a(r^4-1) : ar(r^2-1) :: 10 : 3,$$

$$(r^4-1) : r(r^2-1) :: 10 : 3,$$

$$r^2+1 : r :: 10 : 3,$$

$$\therefore\ 3(r^2+1)=10r$$

$$r^2+1=\frac{10r}{3}$$

$$r^2-\frac{10r}{3}=-1$$

$$r^2-\frac{10r}{3}+(\tfrac{5}{3})^2=\tfrac{25}{9}-1$$

$$=\tfrac{16}{9}$$

$$r-\tfrac{5}{3}=\pm\tfrac{4}{3}$$

$$r=\pm\tfrac{4}{3}+\tfrac{5}{3}$$

$$\therefore\ r=3,\text{ or }\tfrac{1}{3}.$$

(2) $ar+ar^3=a\times ar\times 2$

$a.(1+r^2)=ar\times 2a$

$1+r^2=2a$

$a=\frac{1+r^2}{2}$

$=\frac{1+3^2}{2}$, or $\frac{1+(\frac{1}{3})^2}{2}$

$\therefore\ a=5$, or $\frac{1}{5}$.

$\therefore$ Series $=5,\ 15,\ 45,\ 135,\ 405$;

or, $\frac{1}{5},\ \frac{1}{15},\ \frac{1}{45},\ \frac{1}{135},\ \frac{1}{405}$.

II. FRANCHISE.—Two partners, A and B, gained £140 by trade; A's money was 3 months in trade, and his gain was £60 less than his stock; and B's money, which was £50 more than A's, was in trade 5 months. What was A's stock? (*Piper.*)

Let $x=$ A's stock in pounds;

Then,

$3x+5(x+50):3x::140:x-60$;

$(8x+250)(x-60)=3x\times 140$

$8x^2-230x-15000=420x$

$8x^2-650x=15000$

$x^2-\frac{325x}{4}=1875$

$x^2-\frac{325x}{4}+(\frac{325}{8})^2=\frac{105625}{64}+1875$

$=\frac{105625+120000}{64}$

$=\frac{225625}{64}$

$x-\frac{325}{8}=\pm\frac{475}{8}$

$x=\pm\frac{475}{8}+\frac{325}{8}$

$\therefore\ x=100$, or $-\frac{75}{4}$.

$\therefore$ A's stock was £100.

—o—

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Hygiene.

BY ALFRED CARPENTER, M.D., M.R.C.P. (LOND.),
Chairman of the Council of the Sanitary Institute.

TEA AND COFFEE, AND SIMILAR BEVERAGES.

THAT infusions of vegetable substances fill an important position, as articles of food, in the economy of nature cannot be doubted; they have been used in some form or other from time immemorial. Infusions of bitter herbs are occasionally mentioned in the older writers, as diet drinks. We read that Esau sold his birthright for a mess of pottage. Jacob sod (seethed) pottage, and Esau, being faint, desired it. Whether this was some form of tea, or, which is more probable, some alcoholic drink made from lentils, a farinaceous fruit, is uncertain; I incline to the view that it was alcoholic. There is no doubt as to the bitter waters in the wilderness at Marah. These were sweetened by infusing the leaves of some shrub growing in the neighbourhood, and a kind of tea produced, by means of which the Israelites assuaged their thirst. This use of vegetables for correcting the badness of a water supply, therefore, is very ancient, and in the case of the Israelites deservedly ranked as a miracle; and whilst such infusions are grateful in themselves, we also have the agreeable feeling that they give us the best means of purifying an unwholesome water, and save us from its fatal consequences. Tea and its congeners are, therefore, great sanitary aids. It provides for us 'the cups that cheer, but not inebriate' (Cowper). The usual dietetic infusions and decoctions have active principles, which go by the name of Theine, Caffeine, Cocoine, Guaranine, Theobromine, etc. These principles are alkaline in their nature, and are identical in their effects, both chemically and physiologically; in large doses they produce convulsions, tetanus, paralysis, etc. It is said that their universal use must indicate a universal want in our natural constitution, and that they serve some physiological condition which men of science have not yet been able to point out; but the same has been said of intoxicating beverages; these, however, are thoroughly non-intoxicants. It is singular that those most generally in use are taken from allied classes of vegetables, but they are not restricted to one or two classes, for an immense number of dried leaves and prepared twigs and roots, taken from all divisions in the vegetable kingdom, have been used for similar purposes. The popular infusions are very much alike; they contain volatile oil and astringent matter, with some so-called alkaloid which is crystallizable and is rich in nitrogen. It is possible, as has been pointed out by Liebig, that they may assist in the production of bile. They are closely related in their composition to nerve tissue, and seem to be of service in repairing exhausted brain-matter. They act to some extent in the same direction as alcohol—that is, in retarding the waste of tissue; they seem to enable food to go further than it otherwise would, so that men can, by the aid of tea or coffee, do more work with less exhaustion than with any other kind of ordinary liquid food. It is found that there is a difference also in the result as to the excretion of CO_2, for whilst alcohol diminishes the formation of this debris, both tea and coffee increase the quantity excreted to a slight degree. It has been likened to the action of oil upon delicate machinery, lubricating the animal system, and so enabling it to work rather easier. The late Dr. E. Smith has pointed out that there is a greater depth and more freedom in respiration under their influences, and that the transformation of starchy and fatty food is promoted. But whilst tea induces perspiration and lessens the heat of the body, coffee dries the skin and acts upon the mucous membrane of the bowels. Each, therefore, is suited for different times and different constitutions. Cocoa differs from tea and coffee in containing a large amount of fatty and albuminous matter, and is therefore a more decided food, and has a high nutritive power. It is not so easily digested by a delicate stomach.

There are fictitious teas, coffees, and cocoas, which have none of the true advantages which belong to the real articles. The earth-nut, the chestnut, and the chicory root, do not possess the alkaloid, and have not therefore any of the distinctive properties which belong to the more specific form of diet drinks, and cannot be properly substituted for them; whilst infusions of other herbs are none of them so exhilarating and refreshing as ever to be likely to replace tea and coffee in the estimation of mankind.

AIR: ITS HYGIENIC PROPERTIES.

AIR consists of O 20·9, N 78·4, CO_2 ·04, aqueous vapours ·86, in 100 parts. There are sometimes also

traces of NH_3, N_2O_5, CH_4, and SO_2, and Ozone; the aqueous vapour is, however, very variable. The impurities consist of increase in the quantity of CO_2, in the more decided presence of SO_2 and NH_3, with SH_2 and floating carbon, oily and organic particles of various kinds, the products of smoking chimneys. The oxygen is diminished by all those agencies which lead to oxidation, such as the respiration of animals and consumption of carbon by fires, etc., the oxidation of metals, and decomposition of all organic matters. It is, however, a curious point, that the open air in the worst districts of London and the densest parts of all large cities scarcely varies more than 700 parts in a million in the worst situation as compared with the best; whilst if the air be taken from the pit of a crowded and ill-ventilated theatre when at its worst, there is a loss of not more than 3000 parts in the million as compared with that in the open country. If the quantity of oxygen is diminished from 20·9 to 18·5 per cent. a candle cannot burn in it, and, of course, animal life would soon also cease. A loss which equals three parts in a 1000 (3000 in a million) does not appear to be much, but it has a wonderful effect upon the animal world; we have, therefore, to consider the presence or absence of very minute quantities. Dr. Angus Smith has shown this very clearly in his wonderful work on 'Air and Rain,' which should be consulted by all who are observers in this direction. It is probable that the absence of O (being always accompanied by the presence of some other and unnecessary gas) may not be the real factor in the effects produced, but that it is the introduction of the impurity which has been formed at the expense of the O which has been lost. CO_2 is always present in the air. It is found in the open country, on mountain-tops, and in deep valleys, upon the broad Atlantic, and in the caverns of the earth. Its average is about 4 parts in 10,000. It is largely increased in crowded towns, in ill-ventilated apartments, wherever life abounds and oxidation is in action. The rapid diffusive power which belongs to all gases is very manifest in the case of CO_2, for it is seldom found to exceed ·1 per cent. in the open, in the most densely populated towns. Dr. Angus Smith says there is no difference even in the second decimal place as to the normal in country places, and he considers ·0336 per cent. (which is less than 4 parts in 10,000) in uncontaminated places as a good average. The senses are able to appreciate a difference which is exceedingly minute. This may be observed in any crowded town as compared with some open space in close proximity, and in which the excess is probably less than two parts in 10,000. The ground air of a given place is sometimes much more impure as oxidation is progressing, in consequence of the decay of organic life. CO_2 abounds; it is always excessive in such cases, rising, sometimes, to three or four per cent. There is an antagonism as regards the production of CO_2 between animal and vegetable life; all animals produce it in consequence of the act of living; all vegetables live upon it and return oxygen separated from the carbon back into the atmosphere. There are exceptions in the case of fungi, which give out CO_2, and some forms of animalcular life, which set oxygen free; but the rule is as stated; the one kingdom counteracts the depreciating power of the other. There is a doubt in the minds of some sanitarians as to the injurious effect of excess of CO_2. They refer to the fact that it may be breathed in much larger quantities than normally exist in the atmosphere, without injurious effects, provided the O is undiminished and organic impurities do not abound. It is supposed that there are more dangerous effects from the ammonia compounds and other impurities which are given off by the breath, and which rapidly putrify, and that these are the materials which give rise to danger in densely-peopled districts and over-crowded habitations; that we must look to these gases, and the minute organisms which accompany their production, for the causes of mischief, and not merely to the presence of CO_2 in excess. It is probable that the truth lies in a combination of both, and that small quantities of the ammonia compounds would be comparatively harmless if CO_2 was not in excess and if O was at its normal amount.

Nitrogen.—This part of the atmosphere appears to be negative in its qualities, and as if it existed for the purpose of diluting the oxygen, which in its pure form cannot be breathed for many minutes with impunity. It forms four-fifths of the bulk of the air. It is very inert, and animals die if kept in N simply from the absence of O; and yet in its nascent form it has tremendous power. Its deficiency or excess is of no moment in its usual state, and it need not be further considered, except in connection with its alliance with hydrogen, by which ammonia is evolved.

Ammonia, NH_3.—This gas is always present in the neighbourhood of large towns, either in its simple or in its combined forms. It is always found in the rain which is collected in inhabited districts, but it is the first part of a shower which contains the largest part of ammonia. The rain washes it out of the atmosphere, and sends it into the earth as food for the vegetable world; it combines with sulphurous and nitrous acids, forming ammoniacal salts, which are decomposed if the water is evaporated to dryness, and the acids then combine with the lime or soda salts, etc., which also frequently find access to deposits of rain water. The quantity is extremely minute; it is increased in foggy weather, especially in those fogs which are associated with smoke produced by the consumption of coal. Dr. Angus Smith has calculated the average to be about $\frac{3}{4}$ of a milligramme per litre, and he states on the authority of M. Bineau, that the quantities of ammonia furnished by the rain in each year would be equal to about $\frac{1}{4}$ of that which was afforded by an ordinary manure dressing, but there is a great difference in different districts according to the populous state of the country in which the specimen has been collected. Dr. A. Smith's conclusions are, that ammoniacal salts increase in the rains as towns increase, that they come partly from coal and partly from decomposed albumenoid substances, and may be taken as measures of population.

Nitric Acid, N_2O_5.—When the O of the air acts on the NH_3 or the organic substances containing N, it forms nitric acid. Within certain limits it increases in quantity in the higher regions of the air, and it increases as the quantity of ammonia diminishes. It is more evident in a continental or an inland town than on the sea-coast, and its presence in the air of the British Isles is very much interfered with by the presence of SO_2, which our fuel provides; it is more abundant in the rain which descends at the first onset of a thunderstorm, and it is also probably formed by the passage of electric currents through the air.

Sulphurous and *Sulphuric Acids* (H_2SO_3, *and* H_2SO_4).—The decomposition of protein compounds give rise to the formation of SH_2 and $(NH_4)_2S$, which become oxidised. Sulphates are formed, and they become harmless as regards health. They increase over the land, because of vegetable and animal decomposition; they are in greatest quantities near the ground. The sulphur in the atmosphere is the index of the amount of vegetable and animal decomposition. The sulphur oxides increase in towns in a double ratio, because of the decay of vegetable and animal matter, and to a much greater extent from the wasteful combustion of coal which now goes on. Combustion, when it occurs in an ordinary grate, gives out sulphurous acid, which soon changes into H_2SO_4. Its action is seen upon all the public buildings of London. Westminster Abbey is crumbling from its effects, and all our national monuments suffer from the way in which our atmosphere is polluted by smoking chimneys and the discharge of oxides of sulphur. Its effect is also seen upon the brass door-plates of all large towns. The rain collected in large towns is always more or less acid, according to the quantity of coal consumed. The presence of H_2SO_4 will be, therefore, to some extent, a measure of density of population.

Chlorides of Sodium, etc.—The chlorides are found in the neighbourhood of the sea; they diminish as we leave the coast; but they increase again in large towns, but then the amount of chloride does not rise so high as when a wind blows the air from the sea-coast towards the point selected for observation. This is seen in London. There is an increased amount also in the neighbourhood of alkali works and manufactories which decompose salt, such as is the case in the potteries. These give off hydrochloric acid, and at times produce a most stifling sensation to those breathing it; especially is this so in the neighbourhood of the potteries in Lambeth, which continue to pollute the atmosphere of London to a very serious extent.

(*To be continued.*)

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Friedrich Fröbel.

BY HIS PUPIL, HEINRICH HOFFMAN.

X.—(*continued.*)

FROBEL'S beloved wife began to exhibit symptoms of declining health. She was no longer equal to her arduous duties, and her medical attendant said that this was chiefly due to the climate, which was decidedly unfavourable to her. The sudden loss of her mother, with whom she had always been one in mind and affection, increased her sufferings to an alarming degree, and a speedy change became an imperative necessity.

Fröbel, therefore, resigned his office. Langethal, who remained, was afterwards joined by Ferdinand Fröbel, who, by the breaking up of the Willisau undertaking, was happily open to another engagement.

Family affairs called Fröbel and his wife to Berlin (April, 1836); but he continued to devote himself energetically to the new idea. Its games and plays were to be the principal means of developing the faculties of young children. They had to be spiritualised and shaped into a regular and rational system. Gradually the idea matured in his mind to establish an institution for the culture of early childhood. Barop obtained for him suitable premises in Blankenburg, a small town on the Schwarza, not far from Rudolstadt, renowned for its salubrity and for its beautiful scenery. Quietly, and without any ostentation, the experiment was begun in 1837. For a while it was but an experiment; much was to be learned from experience: deep studies had yet to be made, but the schoolmaster was a thing of the past, and both husband and wife worked together incessantly. They both were, for the time, pupils of the little children, whose lessons never fell on stony ground. Literary labours engaged Fröbel in his spare hours, and in December, 1837, there was issued a weekly paper entitled, *Das Sonntagsblatt*, with illustrative plates, containing the general outlines of the new enterprise. The institute itself was designated, 'The Institute for the culture of Family Life, by the cultivation of the industrial and inquiring propensities of the Child.'

To the student of the Kinder-garten this publication is as instructive as it is interesting, the various occupations of the children, and especially the first five gifts, being minutely described. Owing to Fröbel's unfortunate policy of publishing on his own account, however, his work found but few readers, and the expenses of publication were barely met. It is not very likely that Fröbel would have persisted in a course so unwise had there been no difficulty in finding a publisher. The propagation of the new system, as well as the careful training of teachers, engaged his earnest attention. Lectures were delivered in many places, near and far; teachers came from different institutions to become initiated; and already, before his inner vision, there arose a seminary, the first and indispensable step to whose real existence was the practical sympathy of thoughtful and influential men.

Among his coadjutors, Frankenberg proved an invaluable and most zealous apostle. He travelled about from place to place, carrying copies of the 'gifts' in his carpet bag. In Leipsig and Dresden he met with much success. Krause, the philosopher, and Dr. Herrmann von Leonardi had been, since 1828, among Fröbel's warmest friends and supporters. The former has exercised a great influence on him, and his philosophy found an enthusiastic admirer in Friedrich Fröbel. The latter was very active in propagating the new plans, and inducing teachers to study them in Blankenburg itself. Public opinion soon eulogised, in high terms, Fröbel's labours among the infants, some forty or fifty of whom were daily gathered round him. Visitors of high social position were not rare. The hereditary Grand Duchess of Mecklenburg-Schwerin was so delighted with her visit that she said, 'I should like to be here every day.' It became quite a fashion with tourists, to pay a visit to the infant school at Blankenburg, as one of the sights of Thuringia.

In the spring of 1839, Fröbel, Middendorff, and Frankenberg, went to Dresden, where the Queen and most persons of rank and influence listened attentively to an able address on the new system. It was a complete success. The Queen, after half an hour's conversation with Fröbel, expressed her entire approval, and said, 'These aspirations of yours are very beautiful and very noble.' The result was, that a *play-school*, as it was then called, was established at the 'Brühlsche Terrasse,' under the management of Adolph Frankenberg. Meanwhile, the bright star,

that had so beautifully illuminated Fröbel's path, was fast setting; his dear wife declined from hour to hour. Happy and contented that her husband had at last arrived at his true destination, she was most anxious to conceal from him the real state of her health, lest it might check his ardent zeal. So she still wrote most cheerful letters to Dresden, full of encouragement and good hope. So much the heavier must her loss have fallen on him when, on the 13th of May, 1839, in her fifty-ninth year, she was called to her heavenly home. Honour to her memory! In all his troubles she had been the mainstay of his life, the noble genius that upheld him, and that bore her own troubles with such heroic fortitude as belongs only to a woman of so exalted a character. To her is principally due the inner development of the Kinder-garten idea. In Frau von Holzhausen, Fröbel had been deeply impressed with the sublime greatness of noble-hearted women; his own wife fully illustrated the theory of development to maturity. Deep in her heart she fondly nurtured the Kinder-garten, and hailed with warm enthusiasm a sphere of labour which was so thoroughly in sympathy with her love of mankind, and of children in particular. Her thoughts she expressed in the following lines:—

'Ein *leichter* sinn, der faszt es nicht;
Ein *leiser* sinn, der haszt es nicht;
Ein *lauter* sinn verspottets' nur;
Ein *tiefer* folgt allein der spur.'

A *light* mind comprehends it not; a *gentle* mind dislikes it not; a *haughty* mind will sneer at it; a deep thoughtful mind *alone* follows it.

The day of her funeral was a day of general mourning in Blankenburg and Keilhau. The ladies of both places decorated her coffin with flowers and garlands of orange-blossoms. Fröbel himself was like one close to the borders of eternity, and had not that mighty spirit within him, that incessantly bade him forget everything concerning himself, and follow only the divine call, upheld him, he could not without her have borne life. He took refuge in Keilhau under the gentle care of sympathising friends, whose warm love and veneration revived his drooping spirit.

But his great work did not allow him much leisure to pine over his loss. Besides, how could his troubled heart honour her memory in a manner more dignified and more worthy than by indefatigable devotion to her favourite idea! Such a gigantic mind, no disappointment, no difficulty, no failure could bend. Stronger and stronger he grew by these trials. What gave him this indomitable courage? It was his absolute confidence in the divine character of his mission. But this unshaken trust blinded him, as in the case of all such enthusiasts, to worldly interests. In his opinion, that fierce light that burned within him must find a vivid reflection in the minds of all thinking men and women. Failures and disappointments he would trace, not to his own mistakes, but to a necessary, natural, and, consequently, wise dispensation of Providence. The faintest sunbeam that smiled on his path, however, would make him exuberant with joy beyond all bounds, and would excite in him expectations which would have been inexplicable, and even absurd, in any one but Fröbel. All that he had hitherto done in the new system was, as it were, but a preliminary rehearsal. The presentation of the grand idea, the real *mise-en-scène*, was destined to be connected with the great festival, for the celebration of which Germany taxed to the utmost her powers of imagination. It was on the fourth centenary of the invention of the art of printing, on the first day of May, 1840, that he first published a plan, quite in keeping with his soaring spirit.

It was as follows:—the new institution was to comprise (1) a model school for the physical and intellectual culture of young children; (2) a seminary for teachers of both sexes; (3) a department for the invention and improvement of suitable games and means of occupation; and, finally, (4) a periodical magazine to serve as a nucleus for all persons interested in primary education.

The cost, estimated at 100,000 thalers (£15,000), Fröbel, in his child-like simplicity, thought the easiest thing in the world to realize. It only required one hundred earnest-minded ladies of influence, who would, of course, not object to taking each a share at a cost of about £1 10s. These ladies, who were to be considered founders, were each to engage to enlist ten other ladies under the same condition. In his opinion it was very simple, as there could not be the shadow of a doubt as to the success of this scheme. So confident was he, that he not only sketched detailed plans how the sums were to be advantageously invested, but actually engaged book-keepers, travellers, and others, all of whose claims Barop had afterwards to satisfy.

But of course this plan did not succeed. There was more cold indifference, more ignorance of his benevolent and humanizing labours than he had been aware of. In fact, in 1843, the number of shareholders amounted only to about one hundred and fifty.

Money or no money, the thing had to be done. To be, or not to be, was not the question which money had to decide. So the first Kinder-garten was opened, though not on such a vast scale as had been planned. The local authorities most cordially offered him a suitable building, with garden and playground, and he began work in full earnest.

In 1843 he published a book, 'Mutter und Koselieder,' containing about fifty songs and plays, with handsome pencil etchings. It is written with much warmth of feeling, and illustrates his views on infant life, and of early education in a highly attractive and interesting manner.

Much as has been said against the outward form and polish of the rhymes and poetical effusions, this book abounds in invaluable hints, not only to mothers, but to all who are desirous to study child-nature. It certainly is a real treasure for every Kinder-garten, not only because the peculiar features of the system are clearly indicated, but also because it is the starting-point for a rational and natural education, showing how the tender germs of all the human faculties must be nurtured and cultivated if they are to reach a healthful and satisfactory development.

Frau von Marenholz Bulow, the indefatigable champion of the Kinder-garten, says, with regard to this book: 'Such only as have no understanding of, and no eye for, the mind of a child—such as, forgetful of their own childhood, neither feel nor love nature, can afford to smile at these interpretations of the first infantine plays, as starting-points, as germs of mental development. But if the child's first plays and prattle have no connection with the old man's last deeds,

then where is a connection to be found in human life? where unity in man's inner development? Where this connection is clearly understood, where education leaves the thread which ties the child to the youth unsevered, there only the man will live and act strictly in accordance with the ideal of the youth. There only thorough men, real characters, will be found.'

As to Fröbel's poetry, it certainly offers much ground for adverse criticism as to its artistic merits. But to reject the whole system because of these outward deficiencies, is as unjust and as thoughtless as to condemn a man because his garments are not of the proper cut. First originators cannot be expected to produce their inventions in such a perfection as they appear in later generations. A visit to the 'Rocket,' Stephenson's remarkable engine in the museum at South Kensington, may prove, in its wholesome lessons, of immense benefit to such hasty critics.

(*To be continued.*)

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Physiology.

BY ARTHUR NEWSHOLME, M.D. LOND.,

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CHAPTER X.—THE BLOOD—(*continued*).

Composition of Serum.—100 parts of serum consist of about 90 parts of water, 8 to 9 of proteid matters, and 1 to 2 of fat, extractives, and saline matters.

The greater part of the proteid matter is serum-albumin, which coagulates on heating, rendering the serum almost solid. It is distinguished from egg-albumin by its not being coagulated by æther. The extractives are urea, sugar, kreatin, lactic acid, etc. The chief peculiarity of the saline matter of serum is the preponderance of chlorides and sodium salts over phosphates and potassium salts.

General Composition of Blood.—We have already given separately the composition of corpuscles and serum. It will be convenient to present here, in a tabular form, the general composition of blood.

In 100 parts the various constituents average—

Water	78·4
Serum-albumin	7·
Fibrin-forming substances	0·22
Red corpuscles (dry)	13·
Inorganic salts	0·6
Extractive, fatty, and other matters ...	0·78
	100·

Gases in Blood.—In addition to the constituents already named, blood contains oxygen, carbonic acid, and nitrogen in solution, which can be extracted by the mercurial air-pump. When this is done, it is found that from 100 volumes of blood, an average of 60 volumes of gas can be extracted, measured at 0°C, and a pressure of 760 mm. The composition of this varies in venous and arterial blood. Thus from 100 volumes

	Of oxygen.	*Of carbonic acid.*	*Of nitrogen.*
	VOLS.	VOLS.	VOLS.
Of arterial blood can be obtained	20	39	1 to 2
Of venous blood	8 to 12	46	1 to 2

(*M. Foster.*)

The oxygen in blood is not simply dissolved, as shown by the fact that it does not follow the general law of absorption according to pressure. It has been proved experimentally that serum only absorbs as much oxygen as the same quantity of water; the red corpuscles must therefore be the agents in the absorption of oxygen by blood. As 90 per cent. of dried red corpuscles consists of hœmoglobin, one might infer that this is the agent in the absorption of oxygen, and that this is the case we have already seen.

Most of the carbonic acid in blood is simply dissolved in it, and can be extracted by the mercurial pump. From 2 to 5 per cent. of it requires the addition of an acid to drive it off. It has been supposed that this is in loose combination with sodium carbonate or a phosphate of the same base.

Variations in Composition of Blood.—The composition of the blood is found to differ within certain limits in the same individual under various conditions, in different individuals, and at the same time in different parts of the body.

Each of the main constituents may alter in amount. Thus the water may vary according to the amount of drink taken, of exercise, and other circumstances from 70 to 79 per cent. Within these limits, however, its composition is fairly constant. This is of great importance in relation to the absorption of fluids from the alimentary canal; as these will only quickly penetrate the blood-vessels when they are of less density than the blood.

The albumin again may vary consistently with health from 6 to 7 parts in 100; and the fibrin from 0·2 to 0·3.

The blood of *men* usually presents a somewhat higher specific gravity than of women, and a relatively larger number of red corpuscles. During *pregnancy* the red corpuscles of women's blood diminish in number, while the quantity of white corpuscles and fibrin is increased.

Age has some influence. Fœtal blood is very rich in solid matter, which decreases during childhood, and rises during adult life, to fall again in old age.

When the red corpuscles of the blood are deficient in number, or do not contain the due proportion of hœmoglobin, the oxygen-carrying properties of the blood are materially interfered with. The consequence is that the oxidation processes of the body are hampered, and the patient suffers from shortness of breath on exertion, and is extremely pale. This condition is known as anæmia.

It will be convenient next to discuss the difference between arterial and venous blood, and then the exceptional character of the blood contained in certain veins.

Venous blood differs from arterial in general composition and in colour. (1) In *general composition* arterial blood contains rather more fibrin-forming materials, and rather less albumin and fat; also more oxygen and less carbonic acid. (2) The difference in *colour* is well known, but its cause has been the subject of much discussion. Thus it was supposed that carbonic acid rendered blood dark by causing the red corpuscles to become bi-convex, while oxygen made them bi-concave. It has been clearly proved, however, that the change of colour in blood is chiefly, if not entirely, owing to the oxygen in the lungs converting purple or deoxidised hœmoglobin into scarlet or oxidised hœmoglobin. In the laboratory, this may

be imitated by taking crystals of hœmoglobin and subjecting them to the vacuum of the mercurial air-pump. A definite amount of oxygen is given off, while the crystals become darker and more purple. The same change may be effected in a solution of hœmoglobin by passing in hydrogen to dissociate the oxygen from its loose combination with hœmoglobin.

The portal, hepatic, and splenic veins contain blood differing from ordinary venous blood. The portal vein before entering the liver receives the blood of veins from the stomach and intestines, and from the spleen. The *blood from the stomach and intestines* is usually deficient in solid matters, owing to dilution with the water absorbed, and contains an excess of albumin, as well as various soluble matters absorbed in the process of digestion.

The *blood from the splenic vein* is deficient in red corpuscles, but usually contains an excess of white corpuscles, as well as of albumin and fibrin.

The *blood from the portal vein*, combining the peculiarities of these two factors, is usually more watery, contains fewer red corpuscles and more albumin, and yields a less firm clot than ordinary blood. This analysis does not include the saline, saccharine, and other matters absorbed from the food.

The *blood from the hepatic vein*, which represents the blood of the portal vein after it has been acted on by the liver, contains less water, albumin, and salts than portal vein blood, but an increased amount of extractives, especially of grape sugar (Cl. Bernard.)

In addition to the above instances, blood is doubtless modified in its passage through every organ of the body, as each abstracts the particular nutrient matter it requires, and delivers into the blood its special excretory products. The blood leaving the kidney by the *renal vein* contains less water and salts than ordinary venous blood, and urea is probably absent from it.

Uses of the Blood.—The chief function of the blood is to serve as the great medium of exchange between the different tissues of the body. It carries to every part of the body the materials required for building up the various tissues, in addition to oxygen and oxidisable matter, which, by their combination, produce the chemical and other forces of the body. It brings away from all parts refuse matters, and conveys them to the excretory organs. And lastly, by means of its constant circulation, it warms and moistens every part of the body, and keeps its temperature uniform throughout.

Each constituent of the blood has its special uses. Thus albumin serves to nourish the various tissues containing it; fatty matters replenish the corresponding tissues, maintain the temperature of the body, and form an important part of such secretions as milk and bile; saline matters prevent decomposition of the blood, and aid its absorptive power for gases, besides other functions; while the red corpuscles are the oxygen-carriers for the system in general. The functions of the white corpuscles, apart from their being the source of red corpuscles, is somewhat doubtful; but it has been shown that they occasionally migrate into the tissues surrounding the capillaries, and they may thus have an important influence on nutrition and the development of new tissues.

Coagulation of Blood.—Blood when shed is perfectly fluid. In the case of man, it becomes viscid in about two or three minutes; and in from five to ten minutes it assumes the form of a complete jelly. This jelly is at first of the same size as the fluid blood from which it was formed; but in a few minutes drops of yellowish serum begin to ooze out, and these collecting, the clot or crassamentum to a corresponding extent diminishes in size, and finally floats in the serum. The upper surface of the clot is generally cupped. If a fragment of clot is examined microscopically, it is found to consist of delicate granular fibrils, in the meshes of which are imbedded red and white corpuscles. The horse's blood coagulates very slowly. The consequence is that the red corpuscles, after accumulating in rouleaux, have time to sink before a jelly is produced; a white meshwork, consisting chiefly of white corpuscles and fibrin, and known as the 'buffy coat,' being produced at the upper part of the clot. The same thing happens in human blood in inflammatory conditions.

The rapidity with which blood coagulates is affected by various circumstances.

(1) Moderate warmth (100-120° Fahr.) hastens coagulation, and a temperature near the freezing point of water will retard it indefinitely.

(2) Stagnation is favourable to coagulation, while uniform motion in a closed vessel tends to retard and make it imperfect.

(3) Contact with foreign matter, especially if the points of contact are numerous, favours greatly. Thus the presence of any rough projections in a vessel, or the insertion of any foreign body hastens the process. On the other hand, contact with the interior of a blood-vessel, or any other living tissue, will greatly retard, though it will not prevent coagulation, if the blood is stationary.

(4) The free access of air quickens coagulation, while imperfect aeration, as in death from suffocation (hanging, etc.,) retards it. Similarly, the exclusion of blood from the air, by pouring oil on its surface retards coagulation.

(5) The addition of less than twice the bulk of water quickens coagulation, while in larger quantities it retards it.

(6) The addition of 2 or 3 per cent. and upwards of alkaline and earthy salts retards coagulation; while in large quantities these prevent it altogether, unless the blood be diluted by water.

(To be continued.)

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The New Class-Subject, 'Elementary Science.'

(What to teach, and how to teach it.)

BY RICHARD BALCHIN.

IN the notes of the short course of lessons on zoology to be given to Standard IV., wehave reached the class 'Birds.' If the boys in the Standard are above the average in intelligence, three lessons may well be given on this subject—two on the general characteristics of birds, and one upon the classification into the seven orders. We must take this mode of grouping—unsatisfactory though it be—for want of a better. It may also be mentioned that the first birds to appear in the world—which, however, are extinct, but whose remains are found embedded in the rocks—were half birds and half reptiles. Thus was the class we are now considering linked with the class below it.

LESSON VII.

BIRDS (Circulation and Respiration).

Have a picture of the interior organs of a bird, and, if possible, dissect a fowl before the boys, and show these organs.

(1) Circulation.—The heart is of four chambers, like ours—two auricles and two ventricles. Venous blood enters the right auricle, passes to the right ventricle, thence to the lungs; thence to the left auricle, thence to the left ventricle, from which it is propelled throughout the body. No mixture of venous and arterial blood as in reptiles. Make a rough blackboard drawing to illustrate this circulation. Blood warm; warmer than ours; being more fully oxygenised. Pulsations very rapid; boys who have kept canaries must have noticed this.

(2) Respiration.—By lungs; but a bird's lungs or lights do not hang freely in the chest as ours do; they are in part fastened on to the ribs. The boys have perhaps seen their mothers 'truss' fowls; if so, they must have noticed that the lungs have to be *torn* away; they cannot be removed *entire*, as a sheep's lungs can. Also, the lungs open into 'air-sacs' in various parts of the bird's body, and even communicate with the interior of most of the bones, except in the case of very young birds; so that the bones are filled with air, instead of marrow.

Better at once dispel a very common error as to respiration generally. Boys, and even some grown up people, are constantly affirming that we 'breathe in oxygen, and breathe out carbonic acid gas.' Make the fact clear that the air inspired consists of about four parts by volume of nitrogen and one part of oxygen; the expired air has lost about one-fifth of its oxygen, and gained an equal quantity of CO_2 in its place. Birds do the same.

LESSON VIII.

BIRDS (Skin-covering and Mode of Birth).

Have some feathers, and two eggs; one hard-boiled.

(3) Skin-covering.—Feathers and down; never plates nor scales, nor hair, although in some birds, *e.g.*, the emu, the feathers approach the nature of hair. Notice the parts of a feather. (1) A horny tube, the 'quil.' (2) The 'shaft,' or central thickened portion; this is filled with a light, white spongy mass. (3) The 'webs'; these are continuations or expansions of the shaft, sideways. (4) 'Barbs,' branching off from the webs. Compare a feather with a fish-scale.

(4) Mode of Birth.—The young is hatched from an egg through the agency of heat from the body of the parent bird. The high temperature of birds is especially adapted for this. Break open an egg, and explain very briefly the different parts. (1) The shell, porous, hard, composed of lime. (2) A membraneous covering, or skin, slightly porous. (3) The white or albumen. (4) The yolk or yellow. Cut through the yolk of the hard-boiled egg, and note the grey spot; from this spot the chick begins to be developed.

LESSON IX.—MAMMALS.

Have pictures of duck-mole (ornithorhynchus), kangaroo, dolphin, whale, horse, cow, elephant, seal, lion, rabbit, bat, gorilla, man.

Of these, the lowest in the scale is the ornithorhynchus. It is in many points like a bird; in fact, among existing animals it is the link between birds and mammals.

If possible, show the internal organs of a rabbit and compare them with those of man, as shown in the model supplied by the School Board for London.

(1) Circulation.—Cut open a bullock's heart and show the four chambers. The blood circulates through these four chambers in the same way as in the case of birds. Recapitulate what this is. Show diagram of human heart and note the resemblance. Except in the character of the valves, there is no great difference between the heart of a bird and that of a mammal.

(2) Respiration.—By lungs, same as birds; but the lungs of a mammal are freely suspended in the chest and can be removed, entire. Note this in the case of the sheep's lights that boys have seen in butchers' shops. Also, the lungs do not communicate with air-sacs in various parts of the body as is the case with the lungs of birds. Recapitulate the facts as to the change which the air undergoes during its passage through the lungs. Note:—To show this in a striking manner, I have prepared an apparatus consisting of two Woulfe's bottles and a series of bent glass tubes. These are so arranged that upon applying my mouth to the end of a tube and breathing, the *inspired* air passes through some lime water in one bottle, and the *expired* air through lime water in the other. In the first bottle, the boys observe that the lime water undergoes no change; it remains perfectly clear; while in the second, it becomes milky in appearance, owing to the combination of the carbon dioxide in the expired air with the lime of the lime water, and consequent formation of calcium carbonate, which, unlike lime itself, is insoluble in water.

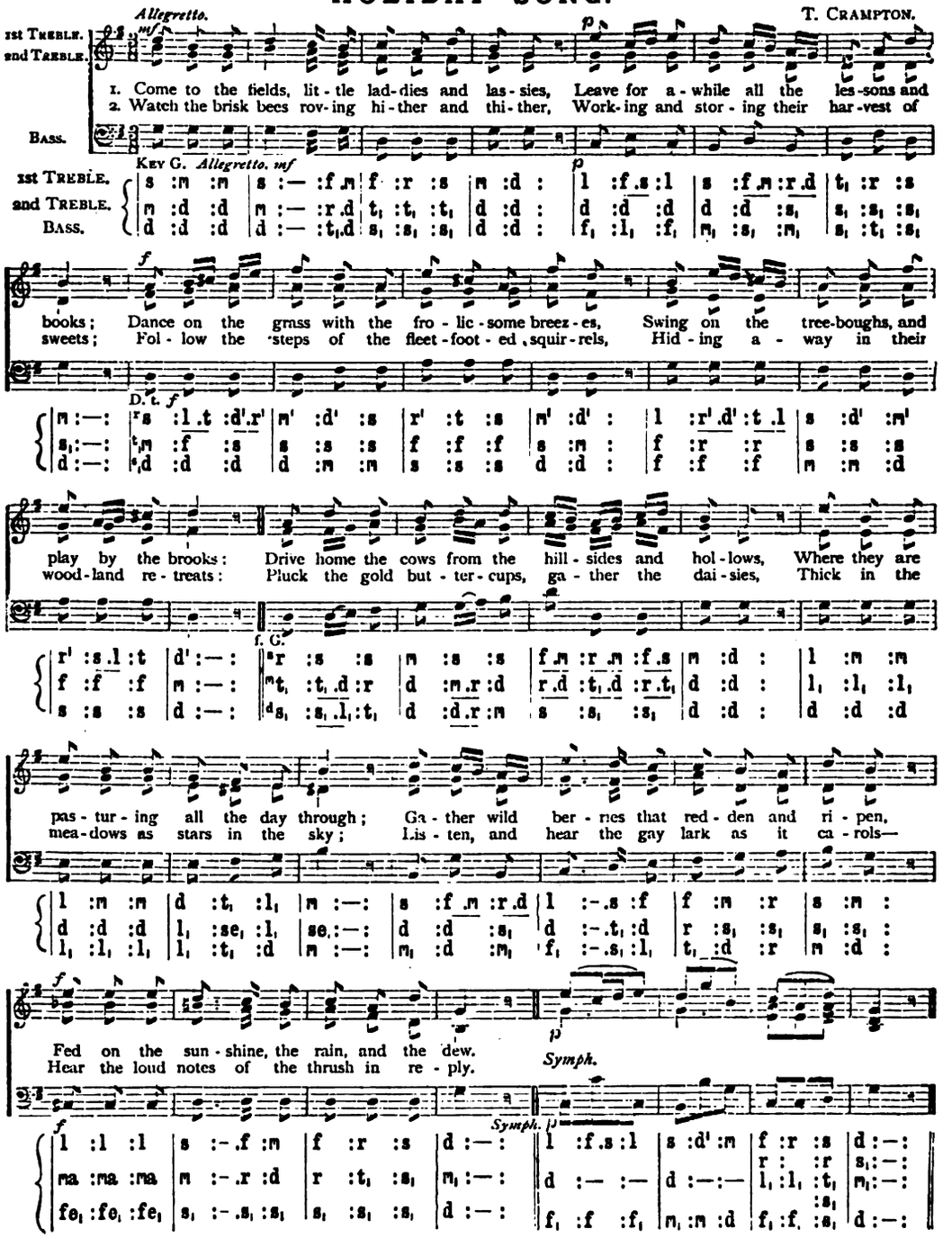
(3) Skin-covering.—By hair, partly or wholly. Never by feathers nor scales.

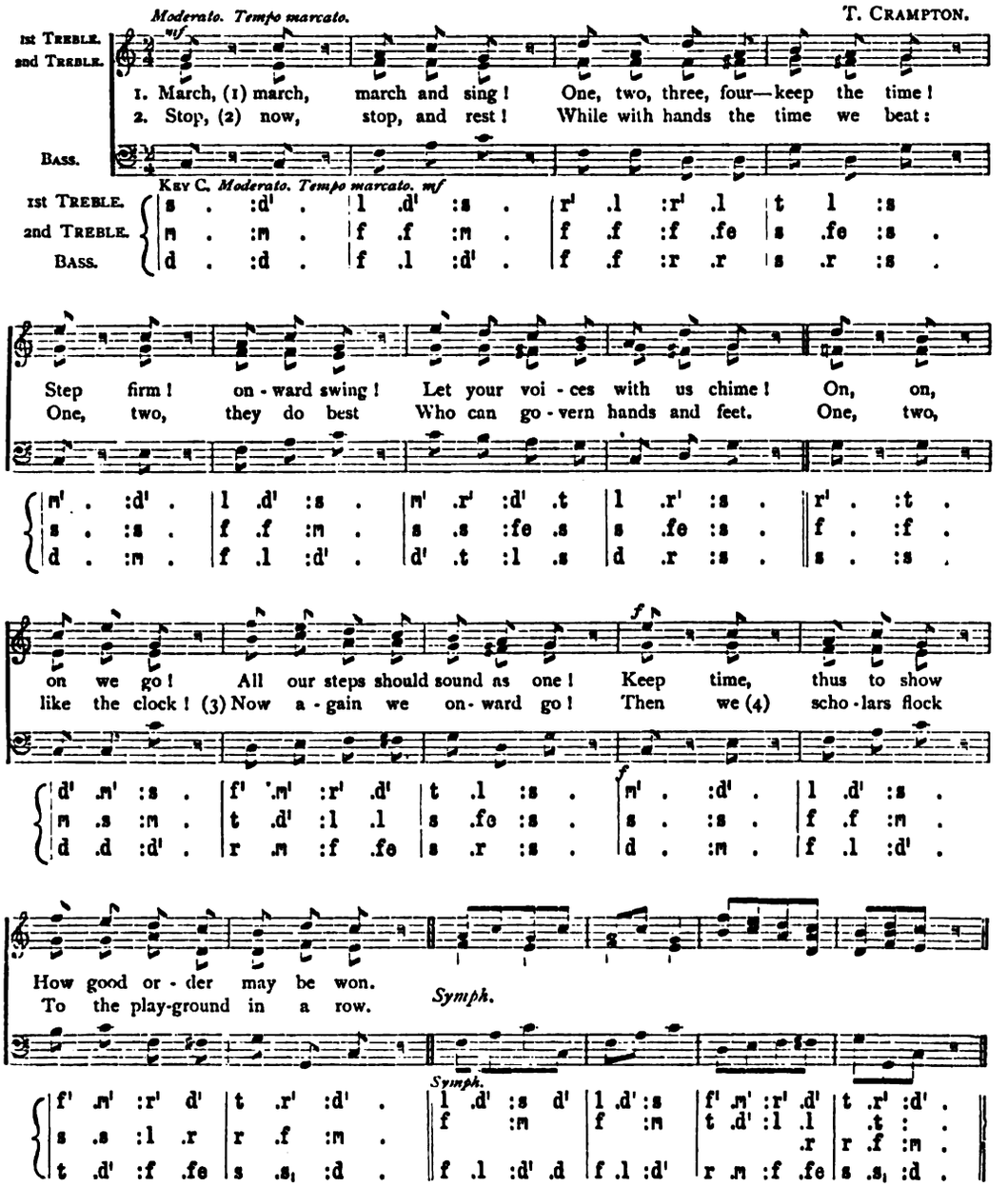
(4) Mode of birth.—Young brought forth alive, and nourished for a time upon a special fluid—milk—formed in the body of the mother. This is the distinguishing characteristic of mammals. Latin, *mammæ*, breasts; hence the name of the class. Boys who have kept rabbits and fowls will readily tell the difference in the mode of birth.

This completes the series of lessons, as far as the Fourth Standard. Here, in most schools, the teaching of Elementary Science as a class-subject ceases. Whatever science is taught in such schools to boys in Standards V., VI., VII., falls under the head of 'specific subjects,' and the place of 'Elementary Science' as a class-subject is taken by geography. It is no doubt felt that it would be a very unsatisfactory state of things if boys should pass through all their standards without any knowledge of geography. More than two class-subjects is not allowed, and one of these *must* be 'English.' As, however, there may be teachers who take 'Elementary Science' as a class-subject throughout the school, or perhaps take it in the Upper Division only, I shall proceed with the notes as heretofore. In my next article, therefore, I propose to place before my readers a syllabus of lessons for one year's work in 'Elementary Science' as a class-subject for Standard V.

(To be continued.)

HOLIDAY SONG.


Allegretto.
T. CRAMPTON.
1st TREBLE.
2nd TREBLE.
BASS.
1. Come to the fields, lit - tle lad-dies and las - sies, Leave for a - while all the les-sons and
2. Watch the brisk bees rov-ing hi-ther and thi-ther, Work-ing and stor - ing their har-vest of
KEY G. Allegretto. mf
books; Dance on the grass with the fro - lic - some breez - es, Swing on the tree-boughs, and
sweets; Fol - low the steps of the fleet - foot - ed squir - rels, Hid - ing a - way in their
play by the brooks: Drive home the cows from the hill - sides and hol - lows, Where they are
wood-land re - treats: Pluck the gold but - ter - cups, ga - ther the dai - sies, Thick in the
pas - tur - ing all the day through; Ga - ther wild ber - ries that red - den and ri - pen,
mea-dows as stars in the sky; Lis - ten, and hear the gay lark as it ca - rols—
Fed on the sun - shine, the rain, and the dew.
Hear the loud notes of the thrush in re - ply.
Symph.

SONG FOR MARCHING.

Moderato. Tempo marcato.
T. CRAMPTON.
1st TREBLE.
2nd TREBLE.
BASS.
1. March, (1) march, march and sing! One, two, three, four—keep the time!
2. Stop, (2) now, stop, and rest! While with hands the time we beat:
KEY C. Moderato. Tempo marcato. mf
Step firm! on-ward swing! Let your voi-ces with us chime! On, on,
One, two, they do best Who can go-vern hands and feet. One, two,
on we go! All our steps should sound as one! Keep time, thus to show
like the clock! (3) Now a-gain we on-ward go! Then we (4) scho-lars flock
How good or-der may be won.
To the play-ground in a row.
Symph.

(1) Keep step to the music, four steps in each bar, so that the footsteps be heard at the rests as well as at the notes. (2) Stop marching, and beat the time with the hands. (3) March onwards again. (4) March off, if convenient, to the playground.

Article 106 (*b*).

Merit Grant in Infant Schools.

BY MRS. MORTIMER,

Lecturer on Kinder-garten at the Home and Colonial Training College, London.

Section II.—Phenomena of Nature.

LESSON—THE SUN.

WHEN do you go to bed? How long do you stay in bed? All night. Why do you not go to bed in the day-time? Because it is light, and we can see to run about and play and do our work. What gives us light in the day-time? The sun. Where is the sun? High up in the sky. When do you see it first? In the morning, directly we wake up. It very often wakes us, because it shines so brightly in at our windows. It is shining in the sky very early in the morning, long before some of us are awake. What does the sun look like? A large ball. Do you like to look at the sun? No; it makes our eyes ache. Do you know why it makes your eyes ache? Because it is so very bright. Is the sun always so very bright? No; sometimes we can look at it quite well; but that is when there is a cloud in front of it. Does it always look the same? No; sometimes it is very red, like fire, and another time it is a bright yellow colour, like gold. Do you always see the sun in the same place? I wonder if any one has ever noticed out of which of these windows he can see the sun in the morning, and which in the evening? That is right; if you look out of this window (teacher pointing to the east) directly you come to school, you will see the sun. Can you see the sun there now? No. Who can see the sun now? You cannot see it at all. Well, I will let Mary go into the playground and look for the sun; then she can come back and tell us where it is. Well, where did you see it, Mary? Over the school. Yes, at this time in the morning the sun is high up in the sky over our heads. Where do you see it the first thing in the morning? Yes; and then it gradually gets up higher and higher, until it is high up over our heads. Does it stay there? No; if you were to watch it you would see that it then goes down lower and lower, until you can see it out of this window (pointing to the west), and then if you still watch it you will see it sink still lower, until it goes quite away, and you cannot see it any more. What happens when it has quite gone? It begins to get dark. Does it get dark all at once? No; it is light at first, then it gradually gets quite dark. What are all little girls and boys doing when it is dark? Yes, they are all sleeping. When will they wake up? In the morning.

All look at the window out of which we see the sun in the morning. Now, that part of the sky where we see the sun in the morning is called the east. We say 'the sun rises in the east.' The children should here repeat, 'The sun rises in the east'; they should also be made to point to the east. Now look at the window out of which we see the sun in the evening. What did I tell you the sun does in the morning? It rises, and then it gets higher and higher, until at midday it is over our heads. What does it do then? It goes down lower and lower until we lose sight of it. When does it do this? In the evening. We say the sun sets in the evening, and the part of the sky where it sets we call the west. The children should then repeat, 'The sun sets in the west.' Point to the west.

You told me that the sun gives us light; there is also something else that we get from the sun; do you know what it is? How do you feel if you stand in the sun? We feel very hot. What makes you feel so hot? The sun. Then the sun gives light and heat. Do you know what good this heat does to the flowers and fruit in the fields and gardens? It makes them grow. Yes, it makes the fruit and flowers grow, and then it makes the fruit and corn get ripe. Do we like all these things to get ripe? Why? They are all things that we eat, and we cannot eat them until they are ripe.

If you put your mother's butter in the sun, what happens to it? And if the sun shines when there is ice or snow on the ground, what happens to it? The heat from the sun makes these things soft, but what does it do to the mud in the road? It makes it quite hard. Then you see the heat makes some things soft and others hard. The children should name some of these things.

If you go out when the sun is very hot, how does it make you feel? Very tired. Yes, and it often makes your head ache. Do you know what you should be very careful to put on when you go out in the sun? Yes, you must never go out in the sun without putting on your hat. Some people who are obliged to work in the sun all day have very bad headaches, and sometimes they are very ill and die. We say they have sun-stroke. Would you like to have sun-stroke? Then what ought you to be very careful about?

Which part of the year is the sun the hottest? And when does it shine for the longest time? Sometimes in the winter we do not see the sun all day, sometimes for two or three days. Where is the sun then?

There is one day in the summer that we call the longest day, because the sun shines longer on that day than on any other. And there is one day in the winter called the shortest day, because the sun does not shine so long on that day as on the others.

An exercise should then be given on the position of the cardinal points and how they are determined.

Section III.—Scenes of Common Life.

LESSON—A GARDEN.

The teacher should begin to question the children about their homes as follows:—How many of you have a garden? Where is it? We have two. Where are they? One in front and one at the back of the house. Have you all two gardens? No. Some of you have only a garden at the back of the house, and some have them only in the front. There is one little boy who says he has not any garden. So you see some of you have two gardens, some have one, and some have none at all.

Are all your gardens the same size? No; some are very much smaller than the others. Do you like to have gardens to your houses? Why? We like to play in them, and to see the flowers. Yes; they are very nice to play in. Now, I want you to think about your gardens, and tell me what you do in them. Well, one little girl says she only plays in hers, but Mary says she puts flowers in hers. How many of you have flowers in your gardens? Do you put the flowers in yourselves? No; our father sees to them. Yes; and he does not like you to touch the flowers. Why not? Because we might spoil them. Some little boys and girls have a piece of garden all to themselves, so they can put in what they like. Now, will you tell me the different parts of the garden? The paths. For what do we use them? For walking on. But may you not walk on all parts of a garden? On which parts must you not walk? On the beds. Which are the beds? Those parts that have things growing in them. Then we have found out two parts of the garden—the paths and the beds. What is there all round the garden? A wall or fence. What is the use of this? That is right; it separates one garden from another, so that each person has his own garden. What do we often have in the middle of the garden? Some more beds or some grass. Yes; we have the grass plat, the paths, the flower beds, and then the walls. Will you tell me of what the paths are made? Generally of gravel. What has to be done to the paths to make them nice? They have to be rolled. What does this do? It makes them hard and smooth. What does your father use to do this? A garden roller. Can you use the roller? No; it is too heavy. Would it do if it were light? No; it would not make the paths hard. Sometimes pieces of grass grow in the paths, and these you must pull up directly, for they spoil the look of the walks. If you have a grass plat in the middle of your garden, what has to be done to it? Yes; the grass has

to be cut and rolled also just like the gravel. If the grass is not kept cut it grows very long, and then looks very untidy. Do you know another name for a grass plat? Yes, it is called 'a lawn.'

Now tell me some of the flowers that you have in your garden. Geraniums, marigolds, nasturtiums, fuchsias, sunflowers, mignonette, etc. Some time ago we had daisies, crocuses, daffodils, and tulips, etc. Yes; they are all very pretty when they bloom. Do you know what your father did to make these flowers come? Yes; he put little seeds into the ground, and then the seeds gradually grew into the plants. Do you not think it very wonderful that these plants should grow out of those little seeds? Did your father sow seeds for the geraniums and fuchsias? No; he put small plants in the ground, and they grew into the large ones we now have. Where did he get them? From the gardener. Yes; some day we will have a long talk about the gardener. You must be very careful when you play in the garden not to break the flowers or dig up the paths. And you should not leave your toys about the garden, for they make it look untidy.

Now I expect some of you have seen other things growing in the garden besides flowers. Well, Harry, what do you say? I have seen onions, potatoes, and cabbages. And you, Tommy? Apples and pears. What do we call the things Harry named? Vegetables. And those Tommy named? Fruits. Do you know what kind of garden we call the one where vegetables and fruits are grown? Yes; a vegetable garden. And what do we call the one we first talked about? A flower garden. Which is generally the larger? The vegetable garden. Why do people plant vegetables in their gardens? Do they look pretty? They want them to eat. Do the apples and pears grow on plants like the cabbage, potato, etc.? No; they grow on trees. Yes; and so do plums, cherries, etc. Then there are some things that grow on bushes. Can you tell me some? Currants, gooseberries, and strawberries. No, strawberries do not grow on bushes; they grow close to the ground on little plants. You see, then, that the vegetables grow on plants, and some of the fruit on trees, and some on bushes, while one little fruit grows on a plant. What is its name? The strawberry.

The teacher should recapitulate the parts and uses of a garden and the different things seen in a garden.

Section IV.—Common Employments.

LESSON—THE BUILDER.

A lesson on the builder will really be an introduction to a course of lessons comprising the following trades: bricklayer, carpenter, glazier, painter, plumber, etc. The teacher, therefore, instead of entering fully into particulars, which would be given under each trade, should see that the children recognise the different sets of men engaged, and the materials individually used by them.

Now, children, we are going to talk to-day about house-building. What do you call the man who builds houses? Probably to this question the teacher would have the following answers: carpenter, bricklayer, builder, etc. She would have to tell the children that the man who sees to the whole of the house is called a builder, and that the carpenter, bricklayer, etc., only do certain parts of the house. The teacher should then repeat the question, What is a builder? so that all the children should answer it properly. The builder gets men to come and work for him. What does he give them? Money. What do we call this money? Wages. Do the men all do the same work? Oh no. Some men are bricklayers, others are carpenters. Now, I will be a builder, and you shall help me to build a house. What shall we first have to do? Build the walls. Not at first; we shall have to dig out the ground. Do you know why? Well, I will tell you. The house would fall down if we tried to build it on the top of the ground. First of all, we must get some men to dig out some of the ground. Then the men would come and build the walls. What do we call these men? Bricklayers. Why? Because they lay the bricks on each other. Are houses always built of bricks? No; sometimes they are made of stone, and also of wood. Well, Harry, what do you say? Sometimes part of the house is stone and the rest of bricks. We must not forget to leave some large holes in the walls. Do you know why we leave these holes? Yes, for the windows. The woodwork of the windows is put in while the bricklayers are building the walls. Then the thick pieces of wood on which the floors are made are put down. What do you call the men who do this work? Carpenters. What else do they do? They nail the floors down and put in the doors. And anything else? Yes, the stairs. If you go to a house when the men are only just beginning, you will not see any stairs. How do you think the men manage without the stairs? They use ladders, and also long poles with boards. Yes, we call these poles and boards the scaffolding. I think that is a long word for you; but you must think of it as three small ones—scaf-fold-ing. Now, what do you mean by the scaffolding? Do you think the carpenters made your school stairs? No. Why not? Because they are made of stone. What do you call the men who do the stonework? They are called masons. Can you tell me what they do in the house? They make the hearths, mantelpieces, and the steps. When the carpenter has finished the windows, what else has to be done to them? The glass must be put in. Who does this? The glazier. Yes, he puts glass in all the windows. Where else do we have glass? In some of the doors. What do we call the top of the house? The roof. Who makes the roof? You do not know; well, look at this model. What are these? They are slates. Yes; and the man who does this work is called 'a slater.' Have you seen anything else used for the roof? Yes, sometimes tiles are used. The teacher might tell the children that in some places straw is used for the roof, and sometimes lead, iron, or zinc.

Now the house is built; but I do not think you would like to live in it yet. What has to be done to it? What colour is the wood? White. Do you live in a house with the wood like this? No; the wood is painted. Well, then, who shall we have in the house now? The painters. They will have a great deal of work to do. Then, while they are doing their work, we have the men in to make the walls look nice. What do we put on the walls? Paper. And what do you call the men who put the paper on the wall? Paper-hangers. But we have forgotten the ceilings of the rooms. These are done before the painter and paper-hanger come. Now I will show you how they are made. Do you remember the thick pieces of wood to which the floors were nailed? Well, under the floor comes the ceiling of the room below. Thin strips of wood called laths are nailed to these thick pieces of wood, and then the plasterer comes and puts the ceiling on. The teacher should here show some plaster. When this is dry, the whitewashers make it nice and white. And now the house is nearly ready. The bell-hangers come and put in the bells and the wires. Why are wires wanted? Tell me something else we want in the house. Water-pipes. Who sees to this? Men called plumbers. Yes, and they do some of the work before the painter comes. And what else do we want? You do not know. The builder has to send the locksmith. What has he to do? He sees to all the locks. Then the gas-fitter is wanted; and there are many other things that the builder has to do before the house is finished. So you see the builder must not be lazy, and he must keep coming to the house to see what is wanted next.

Summary.—The children should be asked to name the different sets of men employed, viz.:—Bricklayers, masons, carpenters, slaters, glaziers, plasterers, whitewashers, painters, paper-hangers, bell-hangers, locksmiths, plumbers, and gas-fitters. Then the various materials used should be written down after the children have mentioned them. For a recapitulatory exercise the children might write the different trades on their slates, and against them the materials used by the workmen. This could be done from memory, or from the summary on the blackboard.

LESSON—THE BRICKLAYER.

Apparatus.—A good picture, showing the man at work, and some of the tools with which he works. A brick, sand, lime, hair, trowel, model of hod, small rule and plumb, and a small level.

Now, children, we are going to talk about the man who makes the outside of the house. Of what does he make it? Of bricks. What do we call the man? A bricklayer. Why? Would you like to know how he puts the bricks together? Who has ever watched the bricklayer at work? Does he use anything besides the bricks? Yes, he has something that looks very much like mud. What does he do with it? He puts it on the bricks, and then puts other bricks on the top of it. And what do we call this? It is called 'mortar.' And what use is the mortar? It sticks the bricks together. Some day I will tell you how the bricks are made, but now I can only tell you about the mortar. It is not mud; it is made of lime and fine sand. Have you seen the men sifting the sand? Did you see the large sieve standing up? How does your mother sift her cinders? Do the men sift the sand in the same way? No, they have so much to sift. Yes, and it would make them very tired, and take them longer to use sifters like your mother's. They stand a very large one up nearly straight. Look at the picture, and tell me how the sieve is standing. It is on the slant. The men then throw the sand from their shovels against the sieve, and then what happens? The fine sand goes through, and falls behind the sieve. And what falls in the front? All the stones and other things which were in the sand. There is something else the men want to mix the lime and sand. They must have water. Yes, and in the summer time they use more water than in winter. Do you know why? Because the mortar dries quickly when the weather is hot. Then there is something else they put in good mortar to make it stick better. Look at this old dry piece of mortar. See, I am breaking it. It is very hard, and I have to hit it very hard to break it up. Now what else can you see? A great many little hairs. Yes, these hairs make the mortar much stronger. They are scraped off the skins of animals, especially that of the cow.

Now of what shape are the bricks? They are oblong. The teacher should here let the children compare the shape of the bricks with the oblongs in Gift IV. These they use in building, and call bricks. Of what colour are the bricks? Sometimes they are white, sometimes red, sometimes a light yellowish brown, etc.

We have talked about the things used to make walls, and now you may tell me about the tools the bricklayers use. Yes, they have a trowel. For what do they use it? To put the mortar on the bricks. Sometimes they want to break the bricks, and then they use the trowel also. The bricklayer holds the brick in one hand, and gives it a quick blow with the trowel, and this breaks the brick. See, here is a trowel. Can you tell me about any other kind of trowel? Yes, the gardener uses a trowel. Is it like this one? Oh no, it is very different. This one is flat, and the one we use in the garden is partly round. What else have you seen bricklayers using? Yes, he sometimes uses a hammer, but this, again, is different to the carpenter's. Look at this one, and tell me how it differs from the other. It is sharp at one end, like a chopper. Yes, the bricklayer uses it to cut the bricks. Have you seen the men carrying bricks? Show me on this picture which tool they use. Can you see a small one on the table? Yes, here it is. We call this a hod. Where does the man carry it? On his shoulder. Do you see this nice cushion made of hair and leather? What do you think is the use of it? It keeps the hod from hurting the man's shoulder. Which part does he hold? The long handle. Do you think you could carry a hod full of bricks? It is a heavy load for a man, especially when he has to go up a high ladder. Have you seen anything else in the hod? Yes, sometimes the men carry mortar. On high buildings the builder often has the bricks and mortar pulled up by long ropes, and then the men do not have to carry the heavy hod up the high ladders. Now, the bricklayer wants to know whether his wall is quite upright, so he has something that he can place against the wall, and by looking at it he can see if the wall has been properly built. Would you like to see one of these things? Here is one. We call it a plumb-rule. You see the piece of lead hanging in the middle? This is called the plummet. How is the plummet held in its place? By a piece of string. Well, the bricklayer puts the rule like this against the wall, and then if the plummet swings quite in the middle he knows that the wall is right. Now look at the plummet; it does not swing in the middle of the rule; this shows that the easel is on the slant. When the bricklayer finds the wall thus, he has to alter it. Then the bricklayer wants to keep the rows of bricks on a level, or, as we say, horizontal. Look at the blackboard, and I will show you this long word—hor-i-zon-tal. Now say the word. What does it mean? Show me something that is horizontal. The bricklayer uses a line. It is a long piece of string, with large pins. What are the pins for? To stick into the wall. When he has stretched the line along, he uses a little thing like this, called a level, to see if his line is quite straight along or level. What else can you say? Horizontal. Do you see the little bubble inside the glass? When this is in the middle it shows the line is level. See, if we put the level on the table, where is the bubble? In the middle. Now put it on the desk, and then what will you say? The bubble is at the end. Yes, and this shows us that the desk is slanting. There is one other tool used by bricklayers. Have you seen anything like this? Yes, it is a square. Well, the bricklayer uses this for the corners. We want the corners of the walls kept square. You take this square, and put it in the corner of the room. What do you notice? The square fits into it. That is the way the bricklayer uses the square. Do you know what has to be done before the bricklayer begins building a wall? Well, the next time you know there are going to be some houses built, you must go and see what the men do first. That is right. You see Harry knows. They dig out some of the ground, and then they fill in this hole with stones, and beat them down. Sometimes they put some concrete. This looks something like mortar with stones mixed with it. What is this part of the house called? The foundation. Yes, and the builder is very particular about the foundations, for he knows the house will not be strong if the foundations are not well made.

Sometimes you have seen men doing something to the fronts of old houses. Do you know what I mean? Painting them. I mean they were doing something to the bricks. Do they paint the bricks? Well, perhaps you have not noticed, so I will tell you. Sometimes the mortar between the bricks wears away, or gets very loose. The bricklayers come and put new mortar between the bricks, so as to fill them up. This is called pointing. This makes the walls quite strong, besides making them look clean and new.

The bricklayer always has some one to help him, called a labourer. Do you know what the labourer has to do? Yes, carry the bricks and mortar to the bricklayer. Yes, he has to fetch whatever the bricklayer wants; so that the bricklayer does not leave off to fetch his own things.

Summary.—For a recapitulatory exercise the children might write out a list of things used by the bricklayer, describe them, and name their uses.

(To be continued.)

Self-Teaching Standard Needlework Manuals.

Miss EMILY G. JONES, Directress of Needlework to the Education Department, will shortly issue a series of cheap STANDARD NEEDLEWORK MANUALS, profusely illustrated with diagrams, etc., and designed with a special view to give self-help to scholars in this important subject. We understand that Mr. Joseph Hughes will be the publisher.

Recent Inspection Questions.

[The Editor respectfully solicits contributions—all of which will be regarded as STRICTLY PRIVATE*—to this column. For obvious reasons, it cannot be stated in which district the questions have been set.]*

Arithmetic.

STANDARD I.

(1)	(2)	(3)
64	920	306
307	736	291
940		
856	184	15
17		
2184		

5 times table.

STANDARD II.

(1)	(2)	(3)	(4)
146	20,601	9)36,073	50,792
7009	7092		16
830		4008 + 1	
5206	13,509		812,672
17			
13,208			

STANDARD III.

(1) Multiply four hundred and seventy thousand and eighty-four by nine hundred and eight.
Ans. 426,836,272.

(2) £	s.	d.
530	11	10
379	15	4¼
150	16	5¾

(3) £	s.	d.
2769	13	10
7039	13	8¾
93	11	8½
4138	19	8
16	18	7¼
14,058	17	6½

(4) A man spent at two different times £827 14s. and £213 11s. 4½d. How much had he remaining out of £1500? Ans. £458 14s. 7½d.

STANDARD IV.

A.

(1) Multiply £86 13s. 4½d. by 75.
Ans. £6500 3s. 1½d.

(2) Divide seven hundred thousand and eighty pounds sixteen shillings by one thousand nine hundred and seventy-six. Ans. £354 5s. $10\frac{0}{4}$d. + 448.

(3) Reduce 70,008 yards to furlongs.
Ans. 318 frls. 8 pls. 4 yds.

(4) A grocer buys a barrel of sugar of 10 cwt. for £15, and sells it at 3¾d. per lb. How much did he gain? Ans. £2 10s. gained.

B.

(1) Divide eight thousand four hundred and eighty pounds twelve shillings and sevenpence by ninety-seven. Ans. £87 8s. 7d.

(2) 9,037,250 ft. to miles.
Ans. 1711 miles 1056 yds. 2 ft.

(3) 26 cwt. 3 qrs. 17 lbs. to ozs.
Ans. 48,208 ozs.

(4) Supposing the average grant for each girl to be 11s. 2d., and for an infant half as much, how much is the grant earned for 113 girls and 49 infants?
Ans. £76 15s. 5d.

C.

(1) Multiply £367 16s. 4¼d. by 246.
Ans. £90,483 3s. 1½d.

(2) Divide one hundred and fifty thousand pounds fifteen shillings by one thousand five hundred and ninety. Ans. £94 6s. 9½d + 780.

(3) How many hours are there in the years 1884 and 1885? Ans. 17,544 hours.

(4) A manager's salary is £237 5s. yearly. How much is that monthly and daily?
Ans. 13s. a day; £19 15s. 5d. a calendar month.

D.

(1) Multiply £64 16s. 7½d. by 68.
Ans. £4408 10s. 6d.

(2) Divide £7063 0s. 11½d. by 806.
Ans. £8 15s. $3\frac{0}{4}$ + 454.

(3) Seven million and seventeen lbs. to tons.
Ans. 3625 tons 0 cwt. 0 qr. 17 lbs.

(4) How often is 1s. 4½d. contained in £2 12s. 3d.?
Ans. 38 times.

STANDARD V.

(1) 860½ at £12 19s. 7½d. each.
Ans. £11,170 7s. 3¾d.

(2) $\frac{1}{3} + \frac{3}{7} + \frac{7}{8}$. Ans. $1\frac{97}{168}$.

(3) 14 yds. at 1s. 11d. a yard; 10½ yds. at 8s. 9d. a yard; 30 yds. at 5s. 9d. a yard; and 10½ yds. at 1s. 11½d. a yard. Ans. £15 11s. 9¼d.

(4) An excursion from Plymouth to Dover costs £2 16s. 3d. each for 47 persons. It was put down in the books for £131 10s. Find the amount of error, and express answer in farthings.
Ans. 660.

STANDARD VI.

(1) If 10 horses plough 15 acres, how many does it require to plough 170 acres? Ans. $113\frac{1}{3}$.

(2) $\frac{8}{9} \times 5\frac{1}{4} \times \frac{3}{14} \times \frac{11}{1}$; divide answer by $\frac{4}{11}$.
$11\frac{1}{16}$. Ans.

(3) What is the simple interest on £1050 for 3½ years at 4 per cent.? Ans. £147.

(4) If a servant receives 25 guineas for one year, how much ought she to receive if she stops from August 27th to January 13th?
Ans. £9 19s. $11\frac{13}{73}$d. (139 days).

STANDARD VII.

(1) What is the average population of the following towns, 34,729, 46,238, 89,726, 51,384, 27,905, and 60,350? Ans. 51,722.

(2) A shipowner insures his vessel valued at £8350 at $4\frac{1}{5}$ per cent. The cargo is worth £4270 at 3½ per cent. What was the total amount of insurance paid to the company? Ans. £500 3s.

(3) If 5 men reap 125 acres in 15 days, in how many days will 20 men reap 75 acres?

Ans. $2\frac{1}{4}$ days.

(4) A clerk's salary is £191 12s. 6d. per annum; what ought he to receive for 60 days; and how much would he lose in last 3 months of the year if his wages were reduced 2s. 8d. a day?

Ans. £31 10s.; £12 5s. 4d.

Grammar.

STANDARD IV.

Parse:—

The little boy in the next house sometimes catches a cold in the head.

With what parts of speech are adverbs used?

Parse:—

I bought his book, and he gave me five shillings for it.

STANDARD V.

Parse and analyse:—

Soon heavier clouds made their appearance over the whole sky.

Form as many adjectives as you can from the nouns 'man' and 'grace.'

STANDARD VI.

Parse the words *in italics*, and analyse:—

When the sun arises, he *very soon* puts to *flight* the vapours with *his searching* beams.

Explain 'ex,' 'in,' 'inter,' as prefixes, and give examples and explanations.

STANDARD VII.

Parse the words *in italics*, and analyse:—

The poor man *whose* leg *was broken, will be taken* to the hospital *whenever* the carriage *comes round.*

Explain:—

*in*termin*able.*
hero*ine.*
abb*ess.*
*incon*ceivable.

Composition.

STANDARDS VI. AND VII.

'The Atlantic Ocean.'

Music.

SINGING TEST.

Time | 1 : 1 : 1 | 1 :—: | 1 :—:— | 1 :1.1 :1 | 1 :—:—

Sing—**m s d' s m s d' ta l s l t d'.**

—o—

ANSWERS TO ARITHMETICAL QUESTIONS IN 'THE SCHOLAR' FOR SEPTEMBER, 1884.

STANDARD III.

A. 1. 7,642,285,200.
2. 467+32.
3. 1014+22.

B. 1. 1239+1671.
2. 796+5501.
3. 913+212.

C. 1. £323 6s. $3\frac{3}{4}$d.
2. £11,780 15s. $2\frac{3}{4}$d.
3. £570 16s. $5\frac{1}{2}$d.

D. 1. £28,196 17s. $11\frac{1}{2}$d.
2. £25,972 18s. $4\frac{1}{4}$d.
3. £9627 5s. $8\frac{1}{2}$d.

E. 1. £280 10s. 10d.
2. £232 18s. $6\frac{1}{4}$d.
3. £5858 8s. $5\frac{1}{4}$d.

F. 1. £2 17s. $0\frac{3}{4}$d.
2. £80 8s. $6\frac{1}{2}$d.
3. 4 times.

STANDARD IV.

A. 1. £216,844 2s. $7\frac{3}{4}$d.
2. £6074 9s. $11\frac{1}{2}$d.
3. £364,118 9s. 3d.

B. 1. £27 8s. $1\frac{1}{2}$d. +227.
2. 2s. $0\frac{3}{4}$d. +2763.
3. £571 16s. $1\frac{3}{4}$d. +4.

C. 1. 33,816.
2. 15 fur. 10 po. 1 yd. 1 ft. 8 in.
3. 1 ac. 2 ro. 15 po. $9\frac{1}{2}$ yds. 6 ft. 128 in. or 10 yds. 0 ft. 20 in.

D. 1. £30 12s.
2. 71 yds. 1 qr.
3. £4 9s. $9\frac{3}{4}$d. +39.

E. 1. £15 13s. $10\frac{1}{2}$d.
2. £2216 18s. $11\frac{1}{4}$d.
3. 266,719

F. 1. £19 16s. 8d.
2. 32 st. 13 lbs.
3. £35 15s. 4d.

STANDARD V.

A. 1. £165 15s. $1\frac{1}{2}$d.
2. £3475 18s. 9d.
3. £71,849 13s. $8\frac{1}{2}$d.

B. 1. £4259 18s. $3\frac{3}{4}$d.
2. £14 6s. $0\frac{1}{2}$d.
3. £317 12s. $7\frac{1}{2}$d.

C. 1. £29 12s. $8\frac{1}{4}$d.
2. 3 qr. 13 lbs. 12 oz.
3. 36 months.

D. 1. $1\frac{3}{4}$.
2. $\frac{1}{12}$.
3. $\frac{33}{121}$.

E. 1. £15 11s. $0\frac{3}{4}$d.
2. £144 14s. $1\frac{1}{2}$d.
3. £32 2s. $10\frac{1}{2}$d.

F. 1. £26 6s. 6d.
2. £1 3s. 4d.
3. £22 3s. $8\frac{1}{2}$d.

STANDARD VI.

A. 1. 78 and 72.
2. '0645161290322 58.
3. £3 8s.

B. 1. £3 17s. $8\frac{3}{11}$d.
2. 18,670$\frac{1}{2}$.
3. $4\frac{1}{2}$ hrs.

C. 1. 2500.
2. £9 6s. $2\frac{1}{2}$d.
3. 11 mos.

D. 1. 468$\frac{1}{4}$ oz. or 29 lbs. $4\frac{1}{4}$ oz.
2. '4725.
3. 3 hours.

E. 1. £100.
2. £20.
3. £4 2s. 6d.

F. 1. 6 times.
2. 3185.
3. 1000.

STANDARD VII.

A. 1. 10 p.c
2. Int. £1 15s. $11\frac{1}{2}\frac{1}{2}$d.
Amt. £291 15s. $11\frac{1}{2}\frac{1}{2}$d.
3. 10 p.c. and 12 p.c.

B. 1. 20 p.c.
2. £40.
3. $18\frac{3}{4}$.

C. 1. £90 1s $2\frac{1}{11}$d.
2. £1 2s. 6d.
3. $33\frac{1}{3}$.

ANSWERS TO ARITHMETICAL QUESTIONS IN 'THE LITTLE LEARNER' FOR SEPTEMBER, 1884.

STANDARD I.

(1) 2628
(2) 109
(3) 279
(4) 2817
(5) 692
(6) 185
(7) 1686
(8) 291
(9) 169
(10) 2247
(11) 855
(12) 197
(13) 1901
(14) 472
(15) 99
(16) 3825
(17) 97
(18) 420
(19) 2119
(20) 619
(21) 681
(22) 2767
(23) 27
(24) 107
(25) 1656
(26) 94
(27) 157
(28) 1964
(29) 179
(30) 109
(31) 3836
(32) 187
(33) 187

STANDARD II.

A. (1) 31,209
(2) 1986
(3) 32,278,848
(4) 3380+6

B. (1) 34,961
(2) 16,965
(3) 58,666,410
(4) 2662+4

C. (1) 899
(2) 42,336,822
(3) 271+28

D. (1) 8978
(2) 36,278,928
(3) 1932

E. (1) 10,884
(2) 6,737,454
(3) 2170

F. (1) 17,299
(2) 56,532,450
(3) 4665+5

G. (1) 415,760
(2) 19,599
(3) 97,466,250
(4) 3350+3

H. (1) 8891
(2) 927,080,000
(3) 4462+6

I. (1) 7,442,786,400
(2) 3,517,515,600
(3) 3,209,365,800
(4) 313,693,380

ANSWERS TO ALGEBRA QUESTIONS IN THE 'SCHOLAR' FOR SEPTEMBER, 1884.

EXERCISE XXXIV.

(1) $x^2+14x+49$; $x+7$
(2) $x^2-14x+49$; $x-7$
(3) $x^2+80x+1600$; $x+40$
(4) $x^2+\frac{4}{15}x+\frac{4}{225}$; $x+\frac{2}{15}$
(5) $x^2+4ax+4a^2$; $x+2a$
(6) $x^2+8mx+16m^2$; $x+4m$
(7) $x^2-\frac{7}{6}x+\frac{49}{144}$; $x-\frac{7}{12}$
(8) $x^3-\frac{4}{5}x+\frac{36}{100}$; $x-\frac{6}{10}$
(9) $x^2+\frac{11}{15}x+\frac{121}{1000}$; $x+\frac{11}{30}$

EXERCISE XXXV.

(1) 2, −12
(2) 3, −1
(3) 10, −11
(4) 3, −17
(5) −1, −12
(6) 10, −110
(7) 3, 2
(8) 1, $-\frac{1}{2}$
(9) 5, −4
(10) 24, $-23\frac{1}{2}$
(11) 6, $-4\frac{1}{2}$
(12) 10, −2
(13) 6, $3\frac{1}{2}$
(14) 2, $-\frac{1}{2}$
(15) 4, 1
(16) 3, $1\frac{1}{2}$
(17) 5, −1
(18) $-a\pm\sqrt{a^2+b^2}$
(19) $\frac{\pm\sqrt{p^2+4q}-p}{2}$
(20) $\frac{\pm\sqrt{b^2+4ac}-b}{2a}$

ANSWERS TO Pupil Teachers' Examination Papers.

JULY 26TH, 1884.

FIRST YEAR.

Pupil Teachers at end of First Year.

Three hours and a half allowed.

Arithmetic.

MALES.

1. By what must $3\frac{1}{7}$ of $1\frac{2}{3}+1\frac{2}{5}$ be divided in order to produce a quotient equal to $3\frac{1}{7}-2\frac{2}{3}$ of $\frac{2}{5}$.

Divisor = Dividend ÷ Quotient.

$\therefore 3\frac{1}{7}$ of $1\frac{2}{3}+1\frac{2}{5}\div 3\frac{1}{7}-2\frac{2}{3}$ of $\frac{2}{5}$
$=(\frac{22}{7}\times\frac{5}{8})+\frac{11}{8}\div\frac{22}{7}-(\frac{11}{4}\times\frac{2}{5})$
$=(\frac{110}{168}+\frac{11}{8})\div(\frac{22}{7}-\frac{22}{84})$
$=\frac{880+231}{168}\div\frac{528-385}{168}$
$=\frac{1111}{168}\times\frac{168}{143}$
$=7\frac{14}{143}$. Ans.

2. Find the value of

$$\left(\frac{8\cdot75}{\cdot0625}-8\cdot75\times\cdot024\right)\div3\cdot125.$$

$$\left(\frac{8\cdot75}{\cdot0625}-8\cdot75\times\cdot024\right)+3\cdot125$$
$=140-\cdot21\div3\cdot125$
$=139\cdot79\div3\cdot125$
$=44\cdot7328$. Ans.

3. Find the value in yards, feet, inches, of—

$\frac{3}{15}$ fur. + $\frac{2}{3}$ pole + $\frac{7}{9/4}$ yd. − $\frac{2}{3}$ in.

		yds.	ft.	in.
$\frac{3}{15}$ fur. $=\frac{2\times220}{15}$ yds.	=	29	1	0
$\frac{2}{3}$ pole $=\frac{5\times11}{9\times2}$ yds.	=	3	0	2
$\frac{7}{9/4}$ yd. $=\frac{7\times36}{24}$ in.	=			$10\frac{1}{2}$
		32	2	$0\frac{1}{2}$
$\frac{2}{3}$ in.	=			$\frac{2}{3}$
		32	1	$11\frac{1}{6}$

4. A and B had equal sums of money, but after A had spent $\frac{1}{3}$ of $\frac{2}{5}$ of his money, and B $\frac{1}{10}$ of $\frac{2}{3}$ of his, B had 5d. more than A. How much had each at first?

A had left $1-(\frac{1}{3}$ of $\frac{2}{5})=\frac{14}{15}-\frac{2}{15}=\frac{12}{15}$
B ,, $1-(\frac{1}{10}$ of $\frac{2}{3})=\frac{29}{30}-\frac{2}{30}=\frac{27}{30}$
The diff. between $\frac{27}{30}$ and $\frac{24}{30}$ = 5d.

$\frac{27}{30}-\frac{24}{30}=\frac{112-111}{120}=1\frac{1}{120}$

$1\frac{1}{120}$ = 5d.

$\therefore \frac{1}{120}=5\times120=600=$ £2 10s. Ans.

d.

FEMALES.

1. Find the cost of 12 acres 1 rood 22 poles at £19 6s. 8d. per acre.

	£	s.	d.		
1 r. = ¼ of 1 a.	19	6	8	= Cost of 1 acre.	
		12			
	232	0	0	= ,,	12 acres.
20 p. = ½ of 1 r.	4	16	8	= ,,	1 rood.
2 p. = $\frac{1}{10}$ of 20 p.	2	8	4	= ,,	20 poles.
	0	4	10	= ,,	2 ,,
	£239	9	10		

= cost of 12 a. 1 r. 22 p. Ans.

2. What is the length of the longest tape measure which can be used so as to exactly measure two walls of 2,916 ft. and 3,582 ft. long respectively.

Measure required = G.C.M. of 2916 and 3582.

2916)3582(1
2916
666)2916(
etc., etc.

G.C.M. = 18.

$\therefore$ Measure req. = 18 ft. or 6 yds. Ans.

3. Make out the following bill and properly receipt it:—

3 lbs. of tea at 3s. 4d. per lb.
4½ ,, sugar at 5½d. per lb.
6½ ,, butter at 1s. 2d. per lb.
3½ ,, cheese at 9½d. per lb.
2 ,, currants at 4½ per lb.
6 ,, raisins at 5½d. per lb.

Clifton, July 26th, 1884.

Mrs. Templeton.

Bought of R. SANGER AND Co.

			£	s.	d.
3	lbs. of tea at 3s. 4d. per lb.		0	10	0
4½	,, sugar at 5½d. per lb.		0	2	$0\frac{3}{4}$
6½	,, butter at 1s. 2d. per lb.		0	7	7
3½	,, cheese at 9½d. per lb.		0	2	$9\frac{1}{2}$
2	,, currants at 4½d. per lb.		0	0	9
6	,, raisins at 5½d. per lb.		0	2	9
			£1	5	11

Received same time,
R. SANGER AND Co.

4. Add together $6\frac{5}{11}$, $3\frac{2}{7}$, $1\frac{11}{14}$, and $\frac{19}{21}$.

$6\frac{5}{11}+3\frac{2}{7}+1\frac{11}{14}+\frac{19}{21}$
$=10\frac{35+63+66+76}{84}$
$=10\frac{240}{84}$
$=12\frac{2}{7}$. Ans.

Grammar.

MALES AND FEMALES.

1. Parse and analyse the following :—

'And now a gallant tomb they raise
With costly sculptures decked ;
And marbles storied with his praise
Poor Gelert's bones protect.'—SPENSER.

2. Distinguish between an 'inflexion' and a 'suffix,' illustrating your answer from the lines above.

1. *And*—cop. conj., joining the sent. 'They raise a gallant tomb' to preceding sentence.
now—adv. of time, qualifying *raise.*
a—dist. adj., limiting *tomb.*
gallant—adj. of quality, qualifying *tomb.*
tomb—com. noun, sing., neut , obj., gov. by *raise.*
they—pers. pron., com., 3rd, plur., nom. to *raise.*
raise—verb, reg. trans., act., ind., pres., 3rd, plur., agreeing with its nom. *they.*
with—prep., showing relation between *sculptures* and *decked.*
costly—adj. of quality, qualifying *sculptures.*
sculptures—com. noun, neut., plur., obj., gov. by *with.*
decked—past participle of trans. verb *to deck*, used as adj., qualifying *tomb.*
and—cop. conj., joining the sents 'They raise a gallant tomb' and 'marbles protect.'
marbles—com. noun, neut., plur., nom. to *protect.*
storied—adj. of quality, qualifying *marbles.*
with—prep., showing relation between *praise* and *storied.*
his—pers. pron., masc , 3rd, sing., poss., gov. by *praise.*
praise—abs. noun, neut., sing., obj., gov by *with.*
poor—adj. of quality, qualifying *Gelert.*
Gelert's—prop. noun, masc., sing., poss., gov. by *bones.*
bones—com. noun, neut., plur., obj., gov. by *protect.*
protect—verb, reg. trans., act., ind., pres., 3rd, plur., agreeing with its nom. *marbles.*

Sentence.	Kind of Sent.	Connective.	Subject.	Predicate.	Object.	Extension.
(*a*) And now a gallant tomb they raise, with costly sculptures decked ;	Princ. sen.	and	they	raise	a gallant tomb decked with costly sculptures.	now (time)
(*b*) And marbles storied with his praise poor Gelert's bones protect.	Princ. sen. co-ord. with (*a*)	and	marbles storied with his praise	protect	poor Gelert's bones.	

2. An *inflexion* is a change in the form of a word to express a change in the meaning or use of the word, as : *sculptures*, the *s* of which is an inflexion denoting the plural number, and *Gelert's*, the *'s* of which is an inflexion denoting the possessive case. A *suffix* is a syllable added to a root, by means of which we change one part of speech into another, as : *-ant* in the word *gallant*, from the root *gala*, and *-ly* in *costly.*

3. Explain the apostrophe in 'Gelert's.' Write down the possessive case plural number of 'woman,' 'ox,' 'mouse,' 'child,' and 'son-in-law.'

The apostrophe (') used to denote the possessive case, stands instead of the vowel in the syllable *es*, which formerly denoted that case.

Singular.	*Plural.*	*Poss. Plural.*
Woman	women	women's.
Ox	oxen	oxen's.
Mouse	mice	mice's.
Child	children	children's.
Son-in-law	sons-in-law	sons-in-law's.

4. When a singular noun ends in an 's' sound, how is the possessive sign affected ? Give examples.

To avoid the repetition of the sibilant sound, the *s* after the apostrophe is omitted, as—for conscience' sake ; Moses' rod ; Felix' room.

Geography.

(*Answer two Questions.*)

1. Draw a map of the coast line from Dungeness to the Lizard Point, naming the capes and inlets.

2. Give an account of British Columbia ? What are its chief productions ?

British Columbia is that part of B. N. America bordering on the Pacific, and has an area twice that of Great Britain. Its eastern side is mountainous, the Rocky Mts. running the entire length, while the Cascade Mts. run parallel with and near to the coast. Through an opening in this range flows the Frazer, the largest river of the colony. British Columbia has great diversity of soil and climate, the mean temperature being like that of Great Britain. The capital of the colony is New Westminster on the Frazer river. Other towns are Hope, Alexandria, and Yale. It became a separate colony in 1858. The chief productions are minerals—as gold, silver, copper, platinum, coal, iron, and marble ; vegetable—as corn, different kinds of timber, pine, fir, oak, ash, cedar, and maple, being found in abundance ; animal—as furs and fish.

3. Describe the mountain system of Australia.

The mountains of Australia lie chiefly in the S.E. of the continent, and near the coast. The chief range is known by different names, as, the Australian Alps, the Blue Mountains, and the Liverpool Range. The highest peak of the range is Mt. Kosciusko, in the Australian Alps, 7300 feet high. The mountains are much less elevated as they near the north, and in the south of Queensland the range divides, one branch ending in Cape Melville and the other at the Gulf of Carpentaria. In Victoria, in addition to this principal range, are the Pyrenees and Grampians, rising to a height of 4500 feet. In Western Australia there are no heights above 1000 feet. S. Australia has ranges of hills known as the Flinders, Ashburton and Macdonald ranges.

History.

1. Name the principal tribes of Britons, and tell what parts of the country they occupied at the time of Cæsar's invasion.

The principal British tribes at the time of the Roman invasion were the *Cantii*, occupying Kent ; the *Trinobantes*, occupying Middlesex and Essex ; the *Cenimagni* or *Iceni*, who covered Norfolk, Suffolk, and Cambridgeshire ; the *Segontiaci*, in Hants and Berks ; and the *Ancolites* and *Bibroci*, in Berks and Wilts.

2. 'Hardship and sorrow !' exclaimed Alfred the Great ; 'not a king but would wish to be without these if he could. But I know that he cannct.' Illustrate this truth from Alfred's history.

Alfred's whole career showed the truth of his statement. While still a youth he was called to fight against the Danes, and at twenty he shared in the victory gained over them at Ashdune, in Berkshire. For seven years after his accession to the throne he fought against them, ultimately being driven from the throne. In 876 he made peace with them, which they, however, immediately broke and seized Exeter. He was successful in 877, but was again defeated in the following year, finally overthrowing the Danes under Guthrum in 879. In 893 a new invasion of the Danes under Hastings took place, and they were not finally repulsed till 897. Besides troubles with the Danes, Alfred was considerably annoyed by his own people. In repressing the crime and promoting order and regularity in his kingdom, he often met with disappointment, and laid himself open to accusations of sternness and cruelty.

3. What was the character of the Danes at the beginning of the eleventh century ? Describe their ships, and explain why they so often got the better of the Saxons.

The Danes at the beginning of the eleventh century were brave and adventurous. The throne of England was occupied by Ethelred the Unready, who was surrounded by traitors of every kind. Neither his forces nor his officers could be depended upon, for on several occasions the latter gave warning to the Danes when they were in danger of being attacked. After the massacre of Danes in 1002, good and bad, the old settlers as well as new comers being all slain, a large fleet, manned only by Danish freemen, came to this country. Their ships were lofty, with high prows on which were figures of lions, bulls, dragons, etc., and their sides were painted with bright colours, shields of burnished steel being hung from stem to stern and glittering in the

sun. At the masthead each ship carried a figure of an eagle or other bird with outstretched wings, and banners embroidered with gold and silver were profusely displayed. The skill of the sailors, the superiority of the ships, and the cowardice or treachery of the English gave the Danes the victory.

Composition.

Write from memory the substance of the passage read to you by the Inspector. The passage was as follows :—

A Cashmere merchant came to Cabul with some handsome shawls, and deposited them with a merchant there. Upon demanding his shawls a few days after, he was met by the Cabul merchant with a flat denial of having ever received them. He appealed to the Ameer, who directed him to repair at a certain hour next day to the shop of the Cabul merchant. Next day the Ameer proceeded in great state to the shop. When he was opposite to it, recognising the Cashmere merchant, he expressed great pleasure at seeing him, and invited him to his palace. A few hours afterwards the Cabul merchant appeared to implore pardon of the friend of the Ameer, not only restoring the shawls, but forcing upon him a large sum of money along with them.

Needlework.

FEMALES.

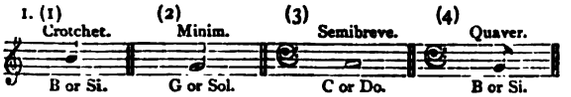
One hour will be allowed for this exercise in the afternoon.

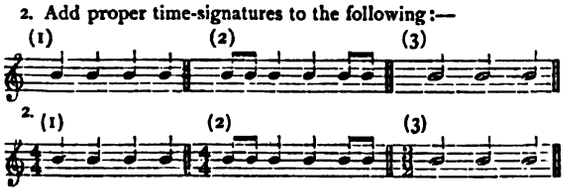
Music.

A quarter of an hour allowed for this paper.

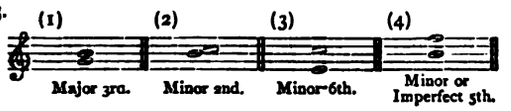
(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write above each of the following notes its value-name (semibreve, &c.), and below each its pitch-name (C, D, or Do, Si, &c.) :—

1. (1) Crotchet. (2) Minim. (3) Semibreve. (4) Quaver.

2. Add proper time-signatures to the following :—



3. Write below each of the following intervals its name (major fourth, &c.) :—

3. (1) (2) (3) (4)

TONIC SOL-FA NOTATION.

1. Re-write the following an octave lower, doubling the value of every note :—

$$|n' :s \quad |f' :r' \quad |l \quad :s \quad |s \quad :- \quad \|$$

1.

$$|n :-|s_1 :-|f :-|r :-|l_1 :-|s_1 :-|s_1 :-|-:-\|$$

2. What does "Key A," or "Key B," mean at the beginning of a tune?

2. That the particular sound called A or B is to be the tonic, and called *doh*.

3. Write the names of the following intervals :—(1) *soh* to *te* ; (2) *te* to *doh*^{1} ; (3) *me* to *soh* ; (4) *te*, to *fah*.

3. (1) Major 3rd ; (2) Minor 2nd ; (3) Minor 3rd ; (4) Minor or Imperfect 5th.

SECOND YEAR.

Pupil Teachers at end of Second Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

1. To draw a straight line at right angles to a given straight line, from a given point in the same.

State and prove the corollary. Is the proof quite sound?

Euclid, Book I., Prop. 11.

The proof of the corollary is objectionable, for in order to erect the perpendicular by the aid of the proposition, the line AB must be produced, and it has to be assumed that it can only be produced in one way, for if it could be produced in two ways as ABC, ABD, then there would be two perpendiculars. The proof is therefore not quite sound.

2. Any two sides of a triangle are together greater than the third side.

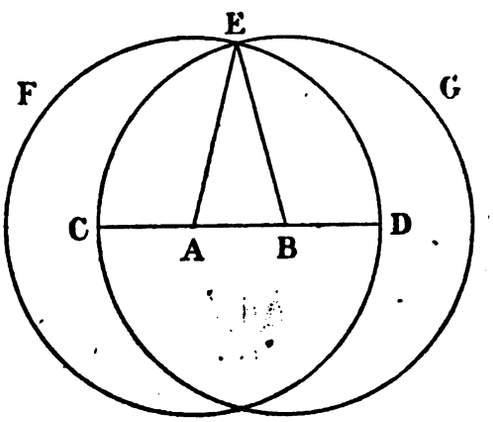
Euclid, Book I., Prop. 20.

3. On a given line describe an isosceles triangle each of whose equal sides shall be double of the base.

Let AB be the given straight line.

It is required to describe on AB an isosceles triangle, each of whose sides shall be double AB.

Produce AB both ways to C and D. Make AC, BD each =AB.



From centre A at distance AD describe circle DEF, and from centre B at distance BC describe circle CEG (Post. 3)

From point E, where circles cut each other, draw EA, EB to points A and B. Then AEB is the △ required.

∵ A is centre of circle DEF, AE=AD (Def. 15).
∵ B is centre of circle CED, BC=BE (Def. 15).
But AD is double of AB, for BD=AB.
And BC is double of AB, for AC=AB.
And doubles of equal things are equal (Ax. 6) ;
∴ BC=AD. And BE=BC, and AE=AD.
∴ AE and BE are also each double of AB.

Therefore a △ AEB has been drawn on a given line, AB, having each of its sides AE, BE double of the base.—Q. E. F.

Arithmetic.

FEMALES.

1. Express $\frac{3}{5}$ of $1\frac{1}{4}$ of $\frac{3}{4}+\frac{3}{5}\div\frac{3}{4}-\frac{1}{10}$ of $31\frac{1}{4}$ as a vulgar fraction in its simplest form.

$$\begin{aligned}
&\tfrac{3}{5} \text{ of } 1\tfrac{1}{4} \text{ of } \tfrac{3}{4}+\tfrac{3}{5}\div\tfrac{3}{4}-\tfrac{1}{10} \text{ of } 31\tfrac{1}{4}\\
&=\tfrac{3}{5}\times 1\tfrac{1}{4}\times\tfrac{3}{4}+\tfrac{3}{5}\times\tfrac{4}{3}-\tfrac{1}{10}\times 31\tfrac{1}{4}\\
&=\tfrac{3}{16}+\tfrac{4}{5}-3\tfrac{1}{8}\\
&=\frac{275+672-436}{420}\\
&=\tfrac{511}{420}\\
&=1\tfrac{91}{420}. \quad \text{Ans.}
\end{aligned}$$

2 Add together $\frac{3}{5}$ of £1, $\frac{1}{2}$ of a florin, $\frac{3}{5}$ of 1s., and $\frac{1}{2}$ of $\frac{1}{4}$ of 13s 4d. ; and subtract the result from $\frac{4}{15}$ of £10,

	s.	d.
$\frac{3}{4}$ of £1 = $\frac{3}{4} \times \frac{20}{1}$s. =	15	0
$\frac{1}{4}$ of 2s. = $\frac{1}{4} \times \frac{24}{1}$d. =	0	4
$\frac{2}{3}$ of 1s. = $\frac{2}{3} \times \frac{12}{1}$d. =	0	8
$\frac{1}{2}$ of $\frac{1}{2}$ of 13s. 4d. = $\frac{1}{2} \times \frac{1}{2} \times \frac{160}{1}$d. =	1	4
	17	4
$\frac{4}{15}$ of £10 = $\frac{4}{15} \times \frac{£10}{1}$ =	£1 12	0
£1 12s. 0d. − 17s. 4d. =	£0 14	8 Ans.

3. Express $\frac{7}{175}$ and $\frac{39}{40}$ as decimals.

$\frac{7}{175} = \frac{28}{700} = \underline{.056}$. Ans.

$\frac{39}{40} = \frac{3{\cdot}9}{4} = \underline{.975}$. Ans.

4. A man gives away in charity $\frac{1}{5}$ of his income, and pays $\frac{1}{10}$ of it in rates and taxes. With these deductions he has £473 13s. 1d. left; what is his gross income?

$1 - (\frac{1}{5} + \frac{1}{10}) = £473\ 13s.\ 1d.$

$\frac{40 - (5+4)}{40} = £473\ 13s.\ 1d.$

$\frac{31}{40} = £473\ 13s.\ 1d.$

$\frac{40}{40} = \frac{£473\ 13s.\ 1d. \times 40}{31}$

$= \underline{£611\ 3s.\ 4d.}$ Ans.

Grammar.

MALES AND FEMALES.

1. I cannot see *what* flowers are at my feet;
Nor what soft incense hangs upon the boughs;
But, in *embalmèd* darkness, *guess each sweet*
Wherewith the seasonable month endows
The grass, the *thicket*, and the fruit-tree *wild*.
—KEATS.

Analyse the above, parsing the words in italics.

2. Point out, and explain the force of, any Latin prefix or termination in the above.

1. ANALYSIS.

Sentence.	Kind of Sent.	Connective.	Subject.	Pred.	Object.	Extension.
(*a*)						
I cannot see	Princ. Sent.		I	cannot see		
(*b*)						
what flowers are at my feet	Noun Sen. to (*a*)		what flowers	are at my feet		
(*c*)						
nor can I see	P.S. co-ord. with (*a*)	nor	[I]	[can see]		
(*d*)						
what soft incense hangs upon the boughs	Noun Sen. to (*c*)		what soft incense	hangs		upon the boughs (*place*)
(*e*)						
but, in embalmed darkness, guess each sweet	Prin. Sent. advers. to (*a*) and (*c*)	but	[I]	guess	each sweet	in embalmed darkness (*place*)
(*f*)						
wherewith the seasonable month endows the grass, the thicket, and the fruit-tree wild.	Adj. sent. to (*e*)	wherewith	the seasonable month	endows	the grass, the thicket and the fruit-tree wild	

PARSING.

What—rel. pro., used as adj. of distinction, qual. *flowers*.
nor = and not—cop. conj., joining the sents. 'I cannot see,' and 'I can see.'
but—disj. conj., joining the sents. 'I cannot see,' and 'I guess.'
embalmed—adj. of quality, qual. *darkness*.
guess—reg. trans. verb, act., ind., pres., 1st, sing., agreeing with *I*.
each—distributive adj., limiting *sweet*.
sweet—abs. noun, neut., sing., obj., gov. by *guess*.
wherewith—cop. conj., joining the sents. 'I guess each sweet,' and 'The month endows.'
thicket—com. noun, neut., sing., obj., gov. by *endows*.
wild—adj. of quality, qual. *fruit-tree*.

2. Prefixes:—
In—in incense, meaning *in*.
em—in embalmed, meaning *in* (through French).
en—in endows, meaning *in* (through French.)
Affixes:—
able—in seasonable, having the force of *to make*, seasonable meaning that which happens in due time; *able* is also an English affix.

3. What is the prefix in the following words:—Occupy, pursue, resemble, perish, pardon.

In occupy (L.) *oc*,	meaning	*in the way of.*
,, pursue (Fr.) *pur*,	,,	*for.*
,, resemble (L.) *re*,	,,	*again.*
,, perish (L.) *per*,	,,	*through, completely.*
,, pardon (Fr.) *par*,	,,	*through.*

4. Paraphrase the following:—

'Hail to thee, blythe spirit!
Bird thou never wert,
That from heaven, or near it,
Pourest thy full heart
In profuse strains of unpremeditated art.'
SHELLEY.—*To a Skylark.*

I bid thee hail, joyous spirit! for to me thou ever seemest more than bird, as from the lofty heights so near to heaven, thy o'ercharged breast sends forth such floods of artless melody.

Geography.

(*Answer two Questions.*)

1. Draw a map of Norway and Sweden, and note upon it, and describe the chief towns.

In NORWAY:—*Christiania*, capital of Norway on Christiania Bay, seat of university, largest town, port, and seat of trade. 77,000 inhabitants.
Bergen, second town, shipbuilding, port, exports dried fish. 33,000 inhabitants.
Trondheim, old capital, and present crowning place of Norwegian kings, port.
Frederickshall, fortress.
Stavanger, port.
Konigsburg, silver mines.
Christiansand, port.
In SWEDEN:—*Stockholm*, capital, near Lake Malar, built partially on islands; chief seat of trade, beautiful environs. 170,000 inhabitants.
Gothenburg, on the Cattegat, place of great trade, has manufactures of cotton, machinery, and sugar; also breweries; shipbuilding. 77,000 inhabitants.
Lund, university.
Upsala, university, archbishopric, iron mines near.
Karlskrono, *Helsinburg*, and *Calmar*, fortresses.

2. From which of our possessions do we obtain tea, coffee, sugar, pepper, and cinnamon?
Tea from China, India, Assam.
Coffee from West Indies, East Indies, Arabia, Ceylon, Brazil.
Sugar from West Indies, Mauritius, East Indies.
Pepper from Jamaica, East Indian Islands, and India.
Cinnamon from Ceylon, East and West Indian Islands.

3. What are latitude and longitude? How are they found? and what is their use in navigation?

Latitude is distance north or south from the equator.
Longitude is distance east or west from a given meridian.
Latitude and longitude are found by observation only. To find the latitude, instruments (sextants, quadrants, etc.,) may be used to ascertain the angle which any fixed star makes with the horizon of the observer. In the tables in the *Nautical Almanack*, the position of this star in regard to the Pole is shown. It may then be found by adding this angular distance to the distance from the pole if the star is below the pole, or subtracting if the star is more elevated than the pole, what the latitude of the observer is; *e.g.*, the elevation of a star is found to be 13° 26′, and from the star to the pole is 15° 14′. ∴ Lat. = 28° 40′.

Longitude is found by ascertaining the difference of time between its noon, and that of a place under any selected meridian. Noon at any place is ascertained by watching the precise moment of the sun reaching the meridian. The time at Greenwich is known by means of the chronometer. As a difference of time of 4′ means a difference of 1°, the long. may be easily calculated. Other means than the use of a chronometer are (*a*) The telegraph; (*b*) Certain phenomena mentioned in *Nautical Almanack;* (*c*) The motion of the moon among the stars.

By means of latitude and longitude sailors tell their exact position at any given time, and so are able to find their way across the trackless sea in safety.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. If a man has £11,500 stock in the 3 per cents., what would he get for it by selling out at 101⅛, the broker charging 2s. 6d. per cent. ?

For every £100 stock of £11,500 he will get
$(£101\frac{1}{8} - \frac{1}{4}) = £101\frac{1}{8}$.
∴ He will get $£101\frac{1}{8} \times 115 = £11,643\ 15s.$ Ans.

2 If the average cost of 20 oxen was £15 19s. 6d., and 8 cost £15 each, and 7 cost £16 each, what was the average cost of the remainder?

	£	s.	d.
20 at £15 19s. 6d. =	319	10	0
8 at £15 =	£120		
7 at £16 =	£112		
∴ 15 cost	232	0	0
and 5 cost	87	10	0

∴ Average of these 5 = £17 10s. 6d. Ans.

3. In what time will £6251 17s. 6d. amount to £7127 2s. 9d. at 3½ per cent. per annum, simple interest?

Total interest = £7127 2s. 9d. − £6251 17s. 6d. = £875 5s. 3d.

$$\text{Int. for 1 year} = \frac{£6251\ 17s.\ 6d \times 3\frac{1}{2}}{100} = £218\ 16s.\ 3\frac{3}{4}d.$$

$$\therefore \text{No. of years} = \frac{£875\ 5s.\ 3d.}{£218\ 16s.\ 3\frac{3}{4}d.} = 4 \text{ years.}$$ Ans.

4. Find a man's daily wages if a reduction of 3d. per day reduces his wages 6 per cent.

6 in every 100 = 3d.
1 ,, ,, = ½
100 ,, ,, $= \frac{3 \times 100}{6}$
= 50d. = 4s. 2d. Ans.

History.

MALES AND FEMALES.

1. Write a short life of William I. and his consort,

William I. was the son of Robert, Duke of Normandy. He was born in 1027, and became duke in 1036. He married Matilda, daughter of Baldwin V., Count of Flanders, and by her had four sons and several daughters. He quelled all the rebellions against him in his own dukedom, got the promise of the crown of England from Edward the Confessor, and when Harold was crowned, in spite of the oath he had made to William to help the latter to the throne, he invaded England in 1066, and gained the battle of Senlac and marched to London, where he was crowned on Christmas Day of the same year. He gave the lands to his Norman followers, established the Feudal System, and built castles in different places so that his power might be maintained in the country. His government was harsh and cruel, as seen in the laying waste of the district for the New Forest, and that of the valley of York. To facilitate his government he had Domesday book compiled. After a reign of 21 years he died from injuries received at Mantes, and was buried at Rouen, 1087.

2. What was the extent of Henry II.'s dominions? Explain how they came to be so extensive?

Henry II. received from his father Anjou, Touraine, and Maine; he derived from his mother the Province of Normandy, and he received as his wife's dower Guienne, Poictou, Xaintogne, Auvergne, Perigord, Angoumois, and Limousin; he claimed and succeeded in getting Nantes, Toulouse, and Brittany. He succeeded Stephen in the throne of England, and added Wales and Ireland to his already extensive dominions by conquest.

3. Edward III. claimed a continental throne; what were the grounds of his claim, and what efforts did he make to enforce it?

Edward III. claimed the throne of France, the help which the king of France gave the Scots being the first provocation to urge him to make that claim. This claim was founded on his descent from Philip, but was utterly untenable as he was debarred from the throne by the Salic law, and even if it had not been in existence there were other claimants to the throne, descendants of older branches of the family of Philip, who had a prior claim.

To gain the throne, Edward fought the naval battle of Sluys (1340), the land battle of Crecy (1346), besieged Calais (1346-7), and fought the battle of Poictiers in 1356. He afterwards gave up his claim to the crown of France, but was invested with Poictou and other southern provinces, and Guienne, free from all homage to the French king. The war, however, was renewed in 1369, and after the Black Prince's death Edward lost nearly the whole of his possessions in France, except Calais, Bayonne, and Bordeaux.

Teaching.

How would you comment upon the following reading lesson to an upper class?

He therefore got a number of light, active, wiry mountaineers from the Pyrenees—men used to scrambling up precipices, and possessed of steady heads and sure feet—and with these he attacked the forests and rocks of Snowdon so successfully, that he drove Llewelyn from their shelter towards the Wye.

Draw attention to the skill displayed in selecting the best men possible for the work the king had to do—mountaineers being best able to fight among the mountains. Elicit or explain, if necessary, the meaning of wiry; show similarity of districts—Pyrenees and Welsh mountains; show how the constant contact with rough, dangerous places gives quickness of eye, coolness of nerve, and sureness of foot.

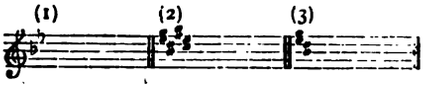
Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

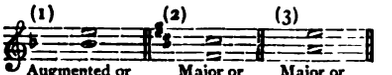
1. Write the key-signatures of each of the following major keys:—(1) of B♭; (2) of E; (3) of D.

1. (1) (2) (3)



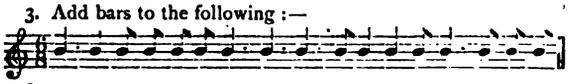
2. Write below each of the following intervals its name (major third, &c.):—

2. (1) (2) (3)

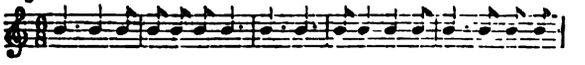


Augmented or Pluperfect 4th. Major or Perfect 5th. Major or Perfect 5th.

3. Add bars to the following:—



3.



TONIC SOL-FA NOTATION.

1. What is the mental effect of (1) *te*; and of (2) *doh*; and of (3) *lah*?

1. (1) Keen, expectant; (2) repose, firm; (3) sad.

2. Write the names of the following intervals:—(1) *fah* to *ray*; (2) *me* to *doh*^{1}; (3) *lah*$_1$ to *soh*.

2. (1) Major 6th; (2) Minor 6th; (3) Minor 7th.

3. Write (1) a six-pulse measure; (2) a four-pulse measure; (3) a two-pulse measure.

3. (1) | : : | : : ‖ (2) | : | : ‖ (3) | : ‖

THIRD YEAR.

Pupil Teachers at end of Third Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including No. 3, if you can.

1. The opposite sides and angles of a parallelogram are equal to one another, and the diameter bisects it, that is, divides it into two equal parts.

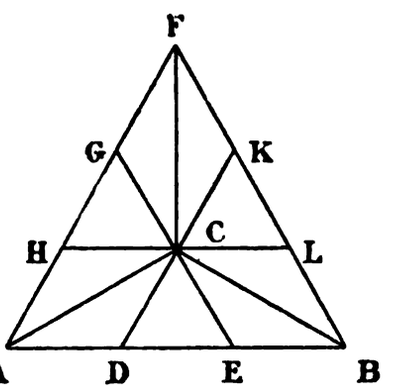
Euclid, Book I., Prop. 34.

2. In any right-angled triangle, the square which is described upon the side subtending the right angle is equal to the squares described upon the sides which contain the right angle.

Euclid, Book I., Prop. 47.

3. Trisect a given line: and hence divide an equilateral triangle into nine equal parts.

Let AB be the given line. Upon AB describe equilateral Δ AFB. Bisect $\angle$'s FAB, FBA by lines meeting in C. Through C draw CD parallel to AF, and CE parallel to FB. AB is divided into three parts at points D and E.



$\because$ FA is parallel to CD, $\angle$ FAC = $\angle$ ACD.
But $\angle$ FAC = $\angle$ CAD (Const.)
$\therefore$ $\angle$ CAD = $\angle$ ACD and (I. 6) DA = DC.
Again: $\angle$ FAB = $\angle$ CDE, and $\angle$ CED = $\angle$ FBA.
$\therefore$ $\angle$ DCE = $\angle$ AFB (I. 32).
And DC = DE.
But DC = DA. $\therefore$ DA = DE.
In the same way it may be shown that EC = ED.

$\therefore$ AD, DE, EB are = to one another, and AB is trisected in D and E.

And since the Δ's CAD, CDE, CEB are upon = bases and between the same parallels, they are equal to one another.

By bisecting the other $\angle$ AFB, and drawing parallels CG, CH, and CK and CL, it may be shown that the other sides may be trisected, and that the Δ's are all equal, and thus an equilateral triangle may be divided into nine equal triangles.

Q. E. D.

Algebra.

(Answer two Questions, including No. 3, if you can.)

1. Find the G.C.M. of

$$2a^7 - 11a^3 - 9 \text{ and } 7(4a^5 + 11a^4 + 81).$$

$$
\begin{array}{r|l}
2a^5 - 11a^2 - 9 & 4a^5 + 11a^4 + 81 \\
 & 4a^5 - 22a^3 - 18 \\
\hline
 & 11)11a^4 + 22a^3 + 99 \\
 & a^4 + 2a^3 + 9 \\
\hline
2a^7 - 11a^2 - 9 & 2a \\
2a^7 + 4a^3 + 18a & \\
\hline
 & -4a^3 - 11a^2 - 18a - 9 \\
 & -1 \\
\hline
4a^3 + 11a^2 + 18a + 9 & a^4 + 2a^3 + 9 \\
 & 4 \\
\hline
4a^4 + 8a^3 + 36 & a - 11 \\
4a^4 + 11a^3 + 18a^2 + 9a & \\
\hline
 & -11a^3 - 18a^2 - 9a \\
 & 4 \\
\hline
 & -44a^3 - 72a^2 - 36a \\
 & -44a^3 - 121a^2 - 198a - 99 \\
\hline
 & 81)81a^2 + 162a + 243 \\
 & a^2 + 2a + 3 \\
\hline
4a^3 + 11a^2 + 18a + 9 & 4a + 3 \\
4a^3 + 8a^2 + 12a & \\
\hline
 & 3a^2 + 6a + 9 \\
 & 3a^2 + 6a + 9
\end{array}
$$

G. C. M. $= a^2 + 2a + 3$. Ans.

2. Simplify $\dfrac{x^4 - y^4}{x^2 - 2xy + y^2} \times \dfrac{x - y}{x^2 + yx}$.

$$
\begin{aligned}
&\frac{x^4 - y^4}{x^2 - 2xy + y^2} \times \frac{x - y}{x^2 + yx} \\
&= \frac{(x^2 + y^2)(x^2 - y^2)(x - y)}{(x - y)(x - y)(x^2 + yx)} \\
&= \frac{(x^2 + y^2)(x^2 - y^2)}{(x - y)(x + y)x} \\
&= \frac{x^2 + y^2}{x} \\
&= x + \frac{y^2}{x}. \quad \text{Ans.}
\end{aligned}
$$

3. Any quantity may be transposed from one side of an equation to the other side by changing its sign.

Solve (1) $\dfrac{7x + 9}{4} - \left(x - \dfrac{2x - 1}{9}\right) - 7 = 0.$

(2) $\dfrac{1}{x - 6} - \dfrac{1}{x - 8} = \dfrac{1}{x - 2} - \dfrac{1}{x - 4}.$

Let $x^3 + y^2 + 6 = 3x^2 + 11$ represent any equation.

Any quantity may be transposed from one side of the equation to the other side by changing its sign. For let $+6$ be the quantity to be transposed: then take $+6$ away from each side, and the equation will be

$$x^2+y^2+6-6=3x^3+11-6$$
$$\text{or, } x^2+y^2=3x^3+11-6$$

i.e., $+6$ has been transposed by changing its sign.

Again: let $3x^3$ be the quantity to be transposed, then take $3x^3$ from each side and the equation will stand thus—

$$x^3+y^3+6-3x^3=3x^3-3x^3+11$$
$$\text{or, } x^3+y^3+6-3x^3=11.$$

i.e., $3x^3$ has been transposed by changing its sign.

(1) $\frac{7x+9}{4}-\left(x-\frac{2x-1}{9}\right)-7=0$

$=\frac{7x+9}{4}-\frac{7x+1}{9}-7=0$

$=63x+81-28x-4-252=0$

$=35x=175$

$=x=5$. Ans.

(2) $\frac{1}{x-6}-\frac{1}{x-8}=\frac{1}{x-2}-\frac{1}{x-4}$

$\frac{(x-8)-(x-6)}{(x-6)(x-8)}=\frac{(x-4)-(x-2)}{(x-2)(x-4)}$

$\frac{-2}{(x-6)(x-8)}=\frac{-2}{(x-2)(x-4)}$

$(x-2)(x-4)=(x-6)(x-8)$

$x^2-6x+8=x^2-14x+48$

$8x=40$

$x=5$.

Mensuration.

Find (in acres, etc.) the area of a square whose diagonal is 9 chains 57 links.

9 chains 57 links = 957 links.

Area of square on diag. $=957\times957=915849$ links.

" side $=\frac{1}{2}$ of $915849=457924{\cdot}5$ links

$=4$ acres 2 r. 12 p. 3·7356 yds.

Arithmetic.

FEMALES.

1. What is the height of a steeple whose shadow was 112 ft. at the same time that a pole 6 ft. 4 in. long cast a shadow of 5 ft. 4 in.?

	ft.	ft.
Height of an object throwing shadow of	$5\frac{1}{3}$	$=6\frac{1}{3}$
" " "	1	$=\frac{6\frac{1}{3}}{5\frac{1}{3}}$
" " "	112	$=\frac{6\frac{1}{3}\times112}{5\frac{1}{3}}$

$=133$ feet. Ans.

2. Divide (*a*) ·0001 by ·00002.

(*b*) 1000 by ·0001.

(*c*) ·001 by ·0001.

(*a*) $\cdot0001\div\cdot00002=5$. Ans.

(*b*) $1000\div\cdot0001=10{,}000{,}000$. Ans.

(*c*) $\cdot001\div\cdot0001$

$=\frac{1}{1000}\times\frac{10000}{1}$

$=\frac{1}{10}\times\frac{999\cdot90}{1}$

$=11{\cdot}1$. Ans.

3. Find the value of ·625 of a guinea + ·54 of 8s. 3d. + ·02½ of £2 15s. 0d.

	s.	d.
·625 of a guinea $=\frac{5}{8}$ of 21s.	$=13$	$1\frac{1}{2}$
·54 of 8s. 3d. $=\frac{54}{100}\times\frac{99}{12}=54$d.	$=4$	6
·02½ of £2 15s. $=\frac{25}{1000}\times\frac{55}{1}$s. $=\frac{1}{2}=$	1	6
	19	$1\frac{1}{2}$ Ans.

4. Express the difference between $\frac{2}{3}$ of 5s. 9d. and $\frac{7}{8}$ of 6s. 4d. as the decimal of half-a-guinea. (Work to 5 places of decimals only.)

$$\frac{\frac{2}{3}\text{ of 5s. 9d.}-\frac{7}{8}\text{ of 6s. 4d.}}{\text{10s. 6d.}}$$

$=\frac{\frac{2}{3}\times\frac{23}{4}-\frac{7}{8}\times\frac{19}{3}}{\frac{21}{2}}$

$=\frac{\frac{23}{6}-\frac{133}{24}}{\frac{21}{2}}$

$=\frac{1932-1900}{\frac{35}{21}}$

$=\frac{32}{35}\times\frac{21}{1}$

$=\frac{672}{35}$

$=\underline{\cdot00725}+$. Ans.

Grammar.

MALES AND FEMALES.

1. Analyse the following, parsing the words in italics:—

'*Lay* thy bow of pearl *apart*,
And thy crystal *shining* quiver,
Give unto the flying *hart*
Space to breathe *how short soever*,
Thou *that mak'st* a day of night,
Goddess excellently bright!'

BEN JONSON. *Hymn to Diana.*

2. Paraphrase it.

Sentence.	Kind of Sent.	Connective.	Subject.	Predicate.	Object.	Extension.
(*a*) Thou goddess excellently bright, lay thy bow of pearl apart.	P.S. contracted in subj		[Thou]	lay	thy bow of pearl	apart (place)
(*b*) And thy crystal shining quiver.	Do. co-ord. to (*a*)	and	[Thou]	[lay]	thy crystal shining quiver	[apart]
(*c*) Give unto the flying hart space to breathe how short soever.	P.S contracted in subj. co-ord. with (*a*)		[Thou]	give	how short soever space to breathe (dir.) unto the flying hart (ind.)	
(*d*) That mak'st a day of night.	Adj. to *thou* in (*d*)		that	mak'st	a day of night	

Lay—irreg. trans. verb, act., imp., pres., 2nd, sing., agreeing with its nom. *thou* understood.
apart—adv. of place, qualifying *lay*.
shining—pres. part., used as adj., qualifying *quiver*.
hart—com. noun, masc., sing., obj., gov. by *unto*.
space—abs. noun, neut., sing., obj., gov. by *give*.
how—adv. of deg., qualifying *soever*.
short—adj. of quality, qualifying *space*.
soever—adv. of degree, qualifying *short*.
that—rel. pro., agreeing with its antecedent *thou*, fem., sing., 2nd, nom. to *mak'st*.
mak'st—irreg. trans. verb, act., ind., pres., 2nd, agreeing with its nom. *thou*.
goddess—com. noun, fem., sing., nom. of address in apposition with *thou*.

PARAPHRASE.

2. O thou beauteous queen, who makest night like day, I pray thee put aside thy pearl-like bow, and the arrow-sheath which shines like silver; give to the hunted stag some short respite, however short that time of rest may be.

3. Of what origin is the suffix of the word 'goddess'? Mention other endings which indicate the feminine gender.

Latin. Other terminations indicating feminine gender: -ine, -trix, -ina, -na, -en, -a, -ster, -tress.

4. Most monosyllabic words are of English origin. Illustrate this by referring to the names of quadrupeds and trees.

Quadrupeds:—Horse, cow, sheep, pig, dog, cat, calf, goat, kid, lamb, foal, pup, mole, mouse, rat, bear, wolf, fox, deer, sloth.

Trees:—Oak, elm, ash, birch, beech, fir, pine, lime, pear, plum.

Geography.

(*Answer two Questions.*)

1. Give full notes of a lesson on the river Nile.

(*a*) *Situation.*—Show map of Africa, and enlarged map of Egypt. Use blackboard for names. The river of Egypt, and once object of wonder and veneration to ancients.

(*b*) *Source.*—Long unknown; notice old way of speaking of 'Mts. of the Moon.' Refer to travels of Livingstone, Speke, Baker, and Grant. Still matter of some doubt. Show number of lakes, Alb. Nyanza, Victoria Nyanza, etc. Former now taken as source of chief tributary, *Bahr-el-abiad*; *Bahr-el-azrek*, from Mts. of Abyssinia.

(*c*) *Course.*—Flows northward. Two streams join at Khartoum (notice central position), form one large stream, flowing through Nubia and Upper Egypt to Mediterranean. Cataracts formed, impassable for vessels except on Nile rising. Confined by hilly district. Widens as it nears Cairo. At capital divides, forms delta; Rosetta and Damietta at separate mouths.

(*d*) *Characteristics.*—Six cataracts. Annual overflow, resulting in great fertility of lower plain; large delta. Valleys called Wadys.

(*e*) *Towns.*—Khartoum, Berber, Dongola, Assouan, Minieh, Memphis, Cairo, Rosetta, Damietta; (Alexandria, Gizeh, Aboukir, near mouths.) Mention historical references, places of ancient greatness, pyramids, cities, etc.

2. Draw a map of the coast of Asia from Aden to Singapore.

3. Give an account of the monsoons of the Indian Ocean.

The monsoons of the Indian Ocean are modifications of the trade winds, and are due entirely to local causes. During the summer the vast arid plains of Thibet, Tartary, and Mongolia, become heated, and the usual trade winds are converted into south-west monsoons. In the other parts of the year these places are cooled rapidly by radiation, and the north-east monsoons prevail.

The south-west monsoons come laden with moisture from the Indian Ocean, and meeting the Ghauts great quantities of rain are precipitated. Crossing the country at the Himalayas they are reduced greatly in temperature, and snow is largely deposited on these heights. They now contain so little moisture, that the great deserts north of the Himalayas never get any rain.

The north-east monsoon carries rain to the east coast of Africa after crossing the Indian Ocean. The change from one monsoon to the other is gradual, and is often accompanied by storms of wind and rain.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. The (true) present worth of a bill due a year hence is £355, what is the amount of the bill, interest being at 3½ per cent. per annum?

Discount taken off is the Int. of P.W.

$$\therefore \text{Debt} = £355 + \frac{355 \times 3\frac{1}{2}}{100}$$
$$= £355 + £12\ 8s.\ 6d.$$
$$= £367\ 8s.\ 6d. \text{ Ans.}$$

2. A grocer bought 1 cwt. of tea for £11 5s., and sold half of it at 2s. 4d. per lb. and half at 2s. 6d. per lb.; what did he gain per cent.?

	£	s.	d.
Selling price = 56 at 2s. 4d. =	6	10	8
56 at 2s. 6d. =	7	0	0
	£13	10	8

Gain = £13 10s. 8d. − £11 5s. = £2 5s. 8d.

∴ Gain per cent. = £11 5s. : £100 :: £2 5s. 8d. : x

$= 20\frac{4}{11}$. Ans.

3. If a square plot of ground contains 961 square yards, how many palings placed a yard apart will be required to go round it?

Side of sq. = $\sqrt{961}$ yards = 31 yards.

∴ No. of palings = 31 × 4 = 124. Ans.

4. If a hare starts 15 yards before a hound and takes 7 leaps of 6 feet each in 2 seconds, whilst the hound takes 9 leaps of 9½ feet each in 4 seconds; in what time will the hound catch the hare?

Speed of hare per sec. $= \frac{7 \times 6}{2} = 4\frac{2}{2} = 21$ feet.

" hound " $= \frac{9 \times 9\frac{1}{2}}{4} = 21\frac{1}{2} = 21\frac{1}{2}$ feet.

Gain per sec. $= 21\frac{1}{2}$ ft. − 21 ft. $= \frac{1}{2}$ foot.

Time to go $\frac{1}{2}$ ft. = 1 sec.

" " $\frac{1}{2}$ " = $\frac{1}{2}$

" " 45 " = $\frac{1}{2} \times 45 \times 8$

= 120 secs. = 2 mins. Ans.

History.

MALES AND FEMALES.

1. Write a short life of James I. and his consort.

James I. of England was the son of Mary Queen of Scots and Lord Darnley, her second husband. On the flight of his mother he became King of Scotland, and on the death of his cousin Elizabeth he became King of England (1603), having married Anne of Denmark in 1590, by whom he had two sons and a daughter. He was learned, but pedantic and conceited. On his accession it became his interest to encourage the doctrine of the 'divine right' of kings, a doctrine which ultimately led to the dethronement of the Stuarts. Early in his reign (1605) occurred the Gunpowder Plot, organised to favour the Roman Catholics; the translation of the Bible was completed (1611), and Ulster was colonized. James was fond of favourites. He first chose Robert Carr, and afterwards George Villiers, whom he created Duke of Buckingham. Anne had a great dislike to the Duke of Buckingham, who was sent to arrange a marriage between Charles, James's eldest son, and the Infanta of Spain. The match, owing to the opposition of the people, did not take place, and Buckingham was disgraced. In this reign Sir Walter Raleigh was released, and went to America in search of gold, but quarrelled with the Spaniards, who clamoured for his execution. Queen Anne tried to save him, but didn't succeed, and he was executed in 1618. James died in 1625, and was succeeded by his son Charles.

His consort Anne died in 1619.

2. Describe Monmouth's insurrection and its suppression.

Immediately after the accession of James II., the Duke of Monmouth landed from the Low Countries, at Lyme in Dorsetshire, and was proclaimed king at Taunton, in 1685. The people in the Western counties flocked to his standard in large numbers, but he was unsupported by the nobility. He attempted to surprise the royal army on Sedgemoor, but was defeated, although his infantry, many armed only with scythes, fought very bravely. Monmouth fled from the field, and was captured two days afterwards. He was beheaded on the 15th July, and his followers were treated with great severity. Many were summarily hanged by Colonel Kirke, whose ferocious soldiers were known as 'Kirke's Lambs.' Then the 'Bloody Assize' was held by Judge Jeffreys, and more than 300 persons were executed, and double that number sold as slaves to the plantations in the West Indies.

3. What was the fate of George IV.'s wife and daughter.

George IV. had married his cousin Caroline, Princess of Brunswick, in 1795, from whom he soon parted. A Bill of Pains and Penalties was brought into Parliament soon after his

accession, to degrade and divorce the Queen on charges of misconduct. The Bill was eventually dropped, but on her presenting herself at the door of Westminster Abbey on the day of the King's coronation, she was refused admittance, and died soon after broken-hearted, August 7th, 1821.

Princess Charlotte married Prince Leopold of Saxe-Coburg, but died, much to the regret and sorrow of the whole nation, after giving birth to a still-born son, on the 4th November, 1818.

Teaching.

Write the notes of a lesson on the 'Races of Mankind.'

(*a*) *Introduction.*—Elicit the fact that all people of the world are not alike in appearance, in colour, stature, etc. Certain peculiarities mark different classes of men.

(*b*) *Varieties of Race.*—Five chief divisions: Caucasian, Mongolian, Malay, Negro, American or Indian.

(*c*) *Distinguishing Features of Various Races.*—Show coloured print, and from examination show:—

1. *Caucasian.*—Has oval face, regular features, hair long, fine, and in waving curls, head well formed, high forehead, upper and back parts well rounded. The most civilized, refined, and powerful nations, both ancient and modern, are of this race.

2. *Mongolian.*—Projecting cheek-bones, flat face, broad skull, flattened at the sides, small eyes obliquely set, yellowish skin, straight black hair, little or no beard.

3. *Malay.*—Skin varies from a light tawny to a deep brown, hair black, crisp, and inclined to curl, head narrow, nose full, and broad towards the lips, bones of face large and prominent.

4. *Negro.*—Black, woolly hair, low and slanting forehead, projecting jaw, flattened nose, thick lips, and black skin.

5. *American.*—Reddish or copper-coloured skin, regular features, aquiline nose, high but retreating forehead.

Compare Mongolian and American; latter an offshoot from former. Malay also a mixture of Mongol and Negro.

Distribution.—(1) Turkey, Arabia, Persia, Hindostan in Asia, nearly all Europe, Egypt and Mediterranean coast of Africa, large areas of N. and S. America, Cape Colony, and Australia.

(2) Central and northern parts of Asia, China, Japan, Burmah, Siam, and Cochin China; Turks, Finns, and Lapps in Europe; and Esquimaux in N. America.

(3) Malay peninsula, Malaysia, Australasia, and Polynesia.

(4) Nearly all Africa.

(5) Parts of the W. of N. America.

Mental and Moral Comparison of Races.—Compare the abilities, the moral and mental faculties of races, show their separate places as regards civilization, and see how physical conditions affect for good or ill the different races.

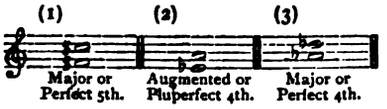
Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

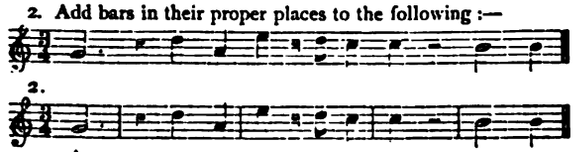
1. Write below each of the following intervals its name (minor third, &c.):—

1. (1) (2) (3)

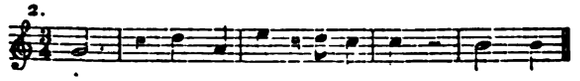


Major or Perfect 5th. Augmented or Pluperfect 4th. Major or Perfect 4th.

2. Add bars in their proper places to the following:—



2.



3. State (briefly) the meanings of the following terms:—(1) *Fortissimo*; (2) *rallentando*; (3) *allegro.*

3. (1) Very loud; (2) gradually slower; (3) quick.

TONIC SOL-FA NOTATION.

1. Write major (perfect) fourths above the following:—(1) *fah*; (2) *ray*; (3) *te.*

1. (1) *ta*; (2) *soh*; (3) *me*'.

2. Re-write the following, doubling the value of every note and rest. Use four-pulse measure:—

$$|d' \;\; :s.f \;|m.,r:d. \;| \;\; :d \;\|$$

2. $|d' :- |s \;:f \;|m \;:-.r|d \;: \;| \;\; : \;\; |d \;:- \|$

3. What do the following terms mean:—(1) *Fortissimo*; (2) *rallentando*; (3) *allegro?*

3. (1) Very loud; (2) gradually slower; (3) quick.

FOURTH YEAR.

Pupil Teachers at end of Fourth Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including No. 3, if you can.

1. If there be two straight lines, one of which is divided into any number of parts, the rectangle contained by the two straight lines, is equal to the rectangles contained by the undivided line, and the several parts of the divided line.

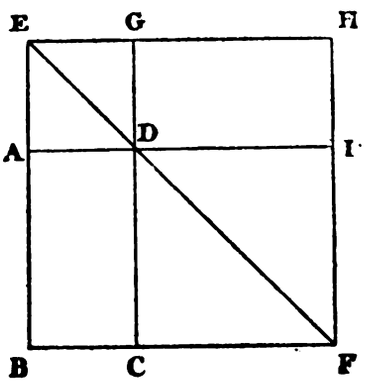
Euclid, Book II., Prop. 1.

2. In every triangle, the square on the side subtending either of the acute angles, is less than the squares on the sides containing that angle, by twice the rectangle contained by either of these sides, and the straight line intercepted between the acute angle and the perpendicular let fall upon it from the opposite angle.

Euclid, Book II., Prop. 13.

3. Any rectangle is half the rectangle contained by the diameters of the squares upon its two sides.

Let ABCD be a rectangle. ABCD = half rect. contained by diags. of sqs. on BA and AD.



On AD describe sq. AG. Join ED, and produce to meet BC produced in F. Through F draw FH parallel to BA. Produce EG and AD to meet FH in H and I.

Then BH is the sq. on BE, and AG and CI sqs. on BA.AE. (I. 43, 44.)

The sq. on BE = sqs. on BA.AE + 2 rect. BA.AE. (II. 4.)

And 2 sq. on BE = 2 sqs. on BA.AE + 4 rect. BA.AE. (Ax. 6.)

But sq. on EF = 2 sq. on BE (I. 47.)

∴ Sq. on EF = 2 sqs. on BA.AE + 4 rect. BA.AE. (Ax. 6.)

And sq. on EF = sqs. on ED.DF + 2 rect. ED.DF. (II. 4.)

∴ Sqs. on ED.DF + 2 rect. ED.DF = 2 sqs. on BA.AE + 4 rect. BA.AE. (Ax. 1.)

But sq. on ED = 2 sq. on EA, and sq. on DF = 2 sq. on BA. Take away these equal parts, and remainder 2 rect. ED.DF = 4 rect. BA.AE. (Ax. 3)

I.e., rect. BA.AE = ½ rect. ED.DF.

But BA.AE = rect. BD, and ED.DF are the diags. of the sqs. on sides of BD.

Wherefore, any rectangle, etc. Q. E. D.

Algebra.

Answer two Questions, including No. 3, if you can.

1. Add $\frac{x-y}{x^2-xy-2y^2}$ to $\frac{x+y}{x^2-3xy+2y^2}$.

$$\frac{x-y}{x^2-xy-2y^2}+\frac{x+y}{x^2-3xy+2y^2}$$
$$=\frac{x-y}{(x-2y)(x+y)}+\frac{x+y}{(x-2y)(x-y)}$$
$$=\frac{(x-y)^2+(x+y)^2}{(x+y)(x-y)(x-2y)}$$
$$=\underline{\frac{2(x^2+y^2)}{(x^2-y^2)(x-2y)}}. \text{ Ans.}$$

2. Solve (1) $\frac{5x}{6}-\frac{3y}{7}=2=\frac{x}{2}-\frac{y}{7}$

(2) $\frac{x+1}{x}+\frac{x}{x+1}=2\frac{1}{6}$.

(1) $\frac{5x}{6}-\frac{3y}{7}=2=\frac{x}{2}-\frac{y}{7}$.

$35x-18y=84$ (1)
$7x-2y=28$ (2)

Mult. 2 by 5

$35x-18y=84$
$35x-10y=140$
$-8y=-56$
$y=\underline{7}$

Substitute value of y in (1).

$35x-126=84$
$35x=210$
$x=6$

$\underline{6, 7}$. Ans.

(2) $\frac{x+1}{x}+\frac{x}{x+1}=2\frac{1}{6}$.

L.C.M. $=6x(x+1)$

$6x^2+12x+6+6x^2=13(x^2+x)$
$x^2+x=6$
$x^2+x+(\frac{1}{2})^2=6+(\frac{1}{2})^2$
$x+\frac{1}{2}=\pm\frac{5}{2}$
$x=\underline{2, -3}$. Ans.

3. The sum of the roots of $x^2+px+q=0$ is $-p$, and their product is q.

Prove this, and apply it to find the sum of the reciprocals of the roots of the same equation.

$$x^2+px+q=0.$$
$$x^2+px=-q$$
$$x^2+px+\left(\frac{p}{2}\right)^2=-q+\left(\frac{p}{2}\right)^2=-q+\frac{p^2}{4}=\frac{p^2-4q}{4}$$
$$x+\frac{p}{2}=\pm\frac{\sqrt{(p^2-4q)}}{2}$$
$$x=-\frac{p}{2}\pm\frac{\sqrt{(p^2-4q)}}{2}$$
$$=\frac{-p\pm\sqrt{(p^2-4q)}}{2}$$
$$\frac{-p+\sqrt{(p^2-4q)}}{2}+\frac{-p-\sqrt{(p^2-4q)}}{2}=\frac{-2p}{2}$$
$$=\underline{-p}.$$
$$\frac{-p+\sqrt{(p^2-4q)}}{2}\times\frac{-p-\sqrt{(p^2-4q)}}{2}$$
$$=\frac{p^2-(p^2-4q)}{4}=\underline{q}.$$

Reciprocals of roots added,

$$=\frac{2}{-p+\sqrt{(p^2-4q)}}+\frac{2}{-p-\sqrt{(p^2-4q)}}$$
$$=\frac{2}{-2p}=\underline{\frac{1}{-p}}. \text{ Ans.}$$

Mensuration.

Give the rules: (1) for finding the area of a triangle when the three sides are given; (2) for finding the length of a circular arc when the angle it subtends at the centre and the radius of the circle are given. Apply the latter to find the length of a quadrant.

(1) From half the sum of the three sides subtract each side separately, then multiply the half sum and three remainders together, and the square root of the product will be the area.

(2) Multiply the radius of the circle by the No. of degrees in the arc, and that product by ·01745329, and the last product will be the length of the arc.

Suppose the radius = 6 in.

Then $6\times90\times\cdot01745329=\underline{9\cdot4247766}$ in. Ans.

Arithmetic.

FEMALES.

1. If eighteen men can dig a trench 17 yards long and 2 yards wide in 17 days, working 5 hours a day, how many men will dig a trench 12 yards long and 4 yards broad in 9 days, working 8 hours a day?

yds. 17 : 12 :: 18 men : x men
yds. 2 : 4
days 9 : 17
hours 8 : 5
$=\underline{30}$ men. Ans.

2. Find the difference between the banker's and true discount on £325 due twelve months hence at 4½ per cent. per annum.

Banker's discount = int. on debt.

$\therefore \frac{325\times4\frac{1}{2}}{100}=$ £14 12s. 6d.

True discount = int. on P. W.

£100 in 12 months yields £4½.

£ £ £
$\therefore 104\frac{1}{2}$: $4\frac{1}{2}$ :: 325 : x
$=$ £13 19s. $10\frac{17}{19}$d.
Diff. = 12s. $7\frac{2}{19}$d. Ans.

3. A man invests £1274 in the 3½ per cents. at 91. What income does he derive thence? (Omit brokerage.)

For every £91 invested he gets 3½.

$\therefore$ Income $=\frac{1274\times3\frac{1}{2}}{91}$
$=\underline{£49}$. Ans.

4. In a class of children 10 are 8 years old, 8 are 9 years old, 12 are 10 years old, 1 is 11 years old, 5 are 7 years old, and 1 is 15 years old. Find the average age of the children in the class.

	years
10 at 8	= 80
8 at 9	= 72
12 at 10	= 120
1 at 11	= 11
5 at 7	= 35
1 at 15	= 15
37	= 333
1	= 9. Ans.

Grammar.

MALES AND FEMALES.

1. Analyse the following, parsing the words in italics:—

No *voice divine* the *storm* allayed;
No light propitious shone;
When snatched from *all* effectual aid
We *perished each alone*;
But *I* beneath a *rougher* sea
And *whelmed* in deeper gulphs *than he*.—COWPER.

2. Point out any words in the above derived from Latin, or from Latin through French.

ANALYSIS.

Sentence.	Kind of Sentence.	Connective.	Subject.	Predicate.	Object.	Extension.
(*a*) No voice divine the storm allayed;	Princ. sent.		no divine voice	allayed	the storm	
(*b*) No light propitious shone;	Princ. sent.		no propitious light	shone		
(*c*) When snatched from all effectual aid we perished each alone;	Adj. sent. (time) to *b*	when	we, each snatched from all effectual aid	perished		alone (manner)
(*d*) But I beneath a rougher sea	Princ. disj. co-ord. with *c*	but	I	[perished]		beneath a rougher sea (place)
(*e*) And whelmed in deeper gulphs	Princ. co-ord. with *d*	and	I	[was] whelmed		in deeper gulphs (place)
(*f*) than he.	Adv. sent. to *e*	than	he	[was whelmed]		[in deep gulphs.]

Voice—com. noun, neut., sing., nom. to *allayed.*
divine—adj. of quality, qual. *voice.*
storm—com. noun, neut., sing., obj., gov. by *allayed.*
no—adj. of number, qual. *light.*
when—adv. conj., cop., joining the sents. 'We perished' and 'no light shone.'
snatched—past part. of to *snatch*, qual. *we.*
all—indef. numl. adj., qual. *aid.*
perished—reg. intrans. verb, act., ind., past, 1st plur., agreeing with *we.*
each—adj., dist. numl., qual. person understood, *or* indef. pers. pro. in apposition with *we.*
alone—adv. of manner, qual. *perished.*
I—pers. pro., masc., sing., 1st, nom. to *perished.*
beneath—prep., showing reln. between *sea* and *perished.*
rougher—adj. of quality, comp. deg., qual. *sea.*
whelmed—past part. of *to whelm*, referring to *I.*
than—cop. conj., joining the sents. 'I was whelmed' and 'he was whelmed.'
he—pers. pro., masc., sing., 3rd, nom. to *was whelmed.*

2. Latin:—voice, divine, propitious, effectual.
Latin through French:—aid, perished.

3. In English almost any part of speech may be used as any other part of speech. Illustrate this.

Ex. 1. The word *round* may be
(1) An adjective, as, Round holes are made by tools.
(2) A noun, as, The daily round of duty was performed.
(3) A verb, as, Round the edges of the stone for me.
(4) An adverb, as, Turn round.
(5) A preposition, as, Go round the house.

Ex. 2. The word *that* may be
(1) An adjective, as, That man.
(2) A relative pronoun, as, This is the house that was struck by lightning.
(3) A compound relative, as, We speak that we do know.
(4) A conjunction, as, I told him that he could not succeed.

Ex. 3. The word *but* is
(1) A conjunction, as, I came, but he stayed.
(2) A preposition, as, All but him had fled.
(3) A noun, as, He stopped me with a 'But.'
(4) A verb, as, But me no buts.
(5) An adverb, But few (only a few) remained till the end.

4. To what period of our literature do the following writers respectively belong:—Alfred the Great, Chaucer, Spenser, Cowper?

Alfred the Great—Old English (450-1100).
Chaucer ... ... Middle English (1250-1485).
Spenser, Cowper ... Modern English (1485 to 1884).

Geography.

(*Answer two Questions.*)

1. Give full notes of a lesson on the Seasons.

Use the globe, an illustration of the seasons, the blackboard, and, if possible, a number of small globes representing the earth as the sun shines on it at different parts of the year.

Cause of Seasons.—Notice the inclination of the earth's axis to plane of its orbit, and that it is always parallel to itself. Make the globe revolve in different parts of the orbit, and show that different parts of the earth receive more or less heat from the sun, and get more of its rays at one time than they do at another. From these deduce: (1) That the cause of the seasons is the varying extent of the sun's influence at different times.

(2) That this varying extent is caused by
(*a*) The earth's axis being inclined.
(*b*) The earth's movement round the sun.
(*c*) The earth's axis being always parallel to itself.

Names and Times of Seasons.—Spring, summer, autumn, winter. Sun vertical to equator twice in the year, when the earth is at opposite ends of a diameter of its orbit, 21st of March and 23rd September. These are times of equal day and night, and called equinoxes.

Sun's rays vertical on Tropic of Cancer 21st June. This is the summer solstice of northern hemisphere (explain solstice), and it is winter of southern hemisphere. Sun vertical on Capricorn 21st December. Summer solstice of southern hemisphere, winter of northern. Illustrate clearly by model and diagram.

Benefit of Seasons.—Variety of climate, products, etc.

2. Draw a map of South America.

3. Contrast the Pacific with the other oceans.

The Pacific is by far the largest of the oceans. In shape it is oval, while that of the Atlantic is a cleft between the two continents, and while it occupies a large proportion of the Torrid Zone, and is, therefore, very hot, the Arctic and Antarctic are covered with eternal ice. While all the other oceans are comparatively destitute of islands, the Pacific is studded with thousands of them, which thus form one of its most distinctive features. The Atlantic is open to the Arctic, but the Pacific has only a connection by Behring's Strait, 36 miles across, and comparatively shallow (25 fath.) The Pacific is not so important a highway for traffic as the Atlantic. The greatest depths of ocean have been found in the Pacific. The great tidal wave has its commencement in the Pacific, but owing to its immense size and freedom from obstruction, its tides are more even, and not so high as those of the Atlantic.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination papers.

Arithmetic.

MALES.

1. Find the exact square root of $5\frac{49}{121}$, and the square root of $\frac{5}{11}$ to 4 decimal places.

$\sqrt{5\frac{49}{121}} = \sqrt{\frac{729}{121}} = \frac{27}{11} = 2\frac{5}{11}$. Ans.

$\frac{5}{11} = \cdot 18181818$

$\cdot 18181818(\cdot 4264$. Ans.

16

82) 218
164

846) 5418
5076

8524) 34218
34096

122

2. If a man invests money in 4½ per cent. railway debentures at 137⅛, what dividend per cent. does he get for his money, the usual brokerage being charged?

For every $137\frac{1}{8}+\frac{1}{8}$ he gets $4\frac{1}{2}$.
$\therefore 137\frac{1}{2} : 100 :: 4\frac{1}{2} : x$
$= \frac{275}{2} \times \frac{100}{1} \times \frac{9}{2}$
$= 3\frac{225}{275}$. Ans.

3. Find the simple interest on £875 from March 10th, 1884, to May 22nd, 1885, at 5 per cent.

From March 10th, 1884 to May 22nd, 1885 = 438 days.

Int. on £875 for 1 year $= \frac{875 \times 5}{100} =$ £43 15s.

days. days. £ s.
$\therefore$ 365 : 438 :: 43 15 : x
= £52 10s. Ans.

4. A, B, and C, whose capitals are as ½, ⅓, and ¼, join in partnership, and after six months A and B increase their capitals by one-half of their original amounts. How would a gain of £275 be divided amongst the three at the end of 9 months?

A's share of capital $= (\frac{1}{2} \times 6) + (\frac{3}{2} \times 3) = 5\frac{1}{2}$
B's ,, ,, $= (\frac{1}{3} \times 6) + (\frac{1}{2} \times 3) = 3\frac{1}{2}$
C's ,, ,, $= (\frac{1}{4} \times 9) = 2\frac{1}{4}$
11

£ £ s.
$\therefore$ A's share of profits $= \frac{5\frac{1}{2}}{11}$ of 275 = 131 5 Ans.
B's ,, ,, $= \frac{3\frac{1}{2}}{11}$ of 275 = 87 10 Ans.
C's ,, ,, $= \frac{2\frac{1}{4}}{11}$ of 275 = 56 5 Ans.

History.

MALES AND FEMALES.

1. What right had James I. to the English throne? Assuming the first Tudor to have been a successful usurper, show that the Stuarts had other claims.

James the First was descended from the eldest daughter of Henry VII., and her brother, Henry VIII., left no lineal descendant after the death of Elizabeth. He was thus the nearest relative of Elizabeth, and as such had the hereditary claim to the throne on her decease.

Assuming that Henry VII. was a successful usurper, the Stuarts might have claimed the throne because they were descendants from James I. of Scotland, who married in 1423 Joanna Beaufort, the daughter of the Duchess of Clarence, by her first husband, the Duke of Somerset, and the descendant of Edward III. by both her parents.

2. By what arguments was the legislative union of Great Britain and Ireland supported? Compare the chief articles of the Scotch Union Act with the corresponding Act for Ireland.

It was urged in support of the Union, that the situation of the two countries was so close, their interests were so identical, that it would be mutually advantageous. But more especially that the emissaries of foreign nations, whose actions were inimical to the well-being of England, would be less powerful, and the chances of discontent and rebellion less great if the Union took place.

The Scottish peers elected were representative only for a parliament, the Irish were elected for life.

Scotland sent 45 members to the House of Commons, Ireland 100.

The title of the country at the union with Scotland called Great Britain, was now changed to Great Britain and Ireland. The union with Scotland provided for each retaining its National Church. The Irish Union Act did not. The Scottish Union Act provided that Scotland should retain its own laws, and administration of the same. The Irish did not.

Each Act provided for the union of the national flags in one.

3. Describe briefly the object and the provisions of the Reform Bill of 1832.

The object of the Reform Bill of 1832 was to amend the representative character of Parliament, to lower the qualification for the franchise, and to increase the electorate. It provided for the disfranchisement of 54 places with less than 2000 inhabitants, and the reduction of the number of members from two to one where the population was between 2000 and 4000. The 143 seats thus obtained were given to the counties, to the metropolis, and to towns of modern growth. It reduced the franchise in boroughs to £10 occupiers, in counties to 40s. freeholders, £10 copyholders, and £50 rental. It shortened the time of election, and provided for registration of voters.

Teaching.

Write out notes of a lesson on the 'MIGRATION OF BIRDS.'

Necessity for Migration.—Note the differences of climate in this and other countries, and the necessity for more clothing in winter than summer. If unobtainable, then change of climate necessary. This latter, the practice with birds.

Birds which Migrate.—Commonest and best known among us, the swallow; wild ducks, cranes, geese, fieldfares and many others, remove to a warmer climate in our winter, and return to us in spring and early summer.

Preparation for Flight.—Notice the gathering of the swallows on the housetops and in the stack-yards and fields, then the rapid flight. Speak of the great flocks of cranes, and geese, and ducks, which visit the fen districts during the later autumn; also notice the height at which the birds fly. Voices often heard, but birds out of sight. Reverse the order, and note the coming of the birds, and the service they render by clearing the atmosphere and earth of troublesome and hurtful insects.

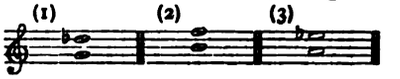
Music.

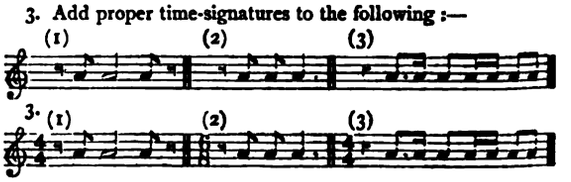
A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write in the treble clef the ascending scale of G minor, using the minor sixth and the sharp seventh, placing the necessary flats, &c., before the notes.

1.

2. Write diminished fifths above the following notes:—

3. Add proper time-signatures to the following:—



3. (1) (2) (3)

TONIC SOL-FA NOTATION.

1. Write an ascending minor scale from *lah*, to *lah*, using the major sixth and the sharpened seventh.

1. l, t, d r m fe se l

2. Write diminished fifths above the following notes:—(1) *lah*, ; (2) *ray* ; (3) *me*.

2. (1) *ma* ; (2) *la* ; (3) *ta*.

3. Re-write the following, halving the value of every note and rest. Use two-pulse measure:—

3. |m :-.f |r :— | :m |r :d ‖
|m .f :r | .m :r .d ‖

The Practical Teacher.

A MONTHLY EDUCATIONAL JOURNAL.

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The numbers of the *Practical Teacher* for February and March, 1884, are now out of print.

Matriculation Hints.

BY HENRY A. REATCHLOUS, M.A. (LOND.), B.Sc.,

Westminster Training College.

THE student has already had occasion to consider the notion of Rate; Velocity, Acceleration, and Force being instances. Five per cent. per annum is a rate of interest; five feet per second per second, which is the same as 300 feet per second per minute, is a rate of acceleration. This notion of rate is of far greater importance and far wider application than appears at first sight, and it should not be passed over until it is completely understood.

But it will be asked is Force nothing but a rate, having no more real objective existence than five per cent.? Most of the existing text-books define it as 'Any cause that changes or tends to change a body's state of rest or motion.' But it was not so defined by Newton; nor is it so used by Thomson and Tait, who have no doubt fixed the meaning of the word for the time to come.

If bodies move, they must do so in some direction and with some velocity. Hence we can represent velocities, accelerations, and forces on paper by drawing lines in the direction the body would move, and proportional to these rates.

Here the student cannot do better than go a little out of his way to learn the meaning of the terms Sine, Cosine, and Tangent. With centre O and radius OP describe a circle. Draw through O a horizontal and a vertical diameter, AOA', BOB' respectively. Suppose now the radius OA' to revolve about the point O in a direction opposite to that of the hands of a watch, When the radius has travelled through 15 degrees drop a perpendicular from A' upon the horizontal line which was its original position. Do this for each 15 degrees up to 90. We have now a set of right-angled triangles, of which the bases have become smaller, the perpendiculars larger, and the hypothenuses remained equal. Now in any right-angled triangle the ratio of the

$\frac{\text{Perpendicular}}{\text{Hypothenuse}}$ is called the Sine of the angle subtended by the perpendicular; the

$\frac{\text{Base}}{\text{Perpendicular}}$ is called the Cosine of the same angle, and the

$\frac{\text{Perpendicular}}{\text{Base}}$ or $\frac{\text{Sin}}{\text{Cos}}$ is called the Tangent of the angle.

As the radius is a constant quantity, it will be seen that the sines and cosines are represented by the perpendiculars and bases of the right-angled triangles, that the sines increase from 0 up to unity (taking the radius as unity) as the angle increases from 0 to 90 degrees, and that the cosine decreases from unity to 0 under like conditions, and, consequently, the tangent being the ratio of the first of these to the second will vary from 0 to infinity as we pass from no degrees to 90. These perpendiculars and bases (sines and cosines) can be easily calculated in terms of the radius for the angles 30°, 45°, and 60°. The student should draw the figures and work them out for himself. We give the values of the sine, cosine, and tangent for the following angles.

Angles	0°	30°	45°	60°	90°
Sine	0	$\frac{1}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{\sqrt{3}}{2}$	1
Cosine	1	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{1}{2}$	0
Tangent	0	$\frac{1}{\sqrt{3}}$	1	$\sqrt{3}$	∞

The terms **Component, Resultant,** should be clearly understood. We often require to find the velocity, acceleration, or force, in other directions than the one in which the body is moving at the time. The most important case of resolution is where we want to replace the velocity by two others at right angles to each other. Let the straight line AB represent the velocity in magnitude and direction. Suppose we want to resolve it along the line AC, which makes an angle of 30 degrees with AB, and along another line AD at right angles to AC. Through B draw BC and BD at right angles to these two lines respectively. AC and AD will represent the velocities required.

$$\text{But } \frac{AC}{AB} = \text{Cosine of } 30, \text{ and } \frac{AD}{AB} = \text{Sine of } 30^\circ$$

That is $AC = AB.\text{Cos. } 30$, and $AD = AB \text{ Sin. } 30^\circ$.

Hence, to resolve a force in any direction, with the one in which it is acting, we have only to multiply the number representing the force by the cosine of the angle which that direction makes with its own.

The proposition called the parallelogram of forces should be well studied. There is often some confusion about what is called the triangle of forces, perhaps because the two lines are not the actual paths along which the forces act, but only parallel to them.

If three forces are in equilibrium, any one of them is equal and opposite to the resultant of the other two. If we resolve any number of forces acting on a particle in two directions at right angles to one another, and the sum of these resolved parts vanishes in both directions, there will be equilibrium. We have hitherto taken it for granted that the forces act in one place, and that the motion is that of translation.

But for a rigid body to be at rest there must not only be no motion of translation, there must be none of rotation. When the direction of a force does not pass through a point, it may produce a motion of rotation about that point, and its **importance** in that respect is called the **moment** of the force about that point. It is measured by the product of the number of units of force, and the number of units of length in the perpendicular from the point upon the direction of the force. Consider a lever in equilibrium. Disregard the weight of the lever, and suppose unequal masses are attached to the ends. Then if the lever is horizontal, the forces are acting at right angles to the arms, and the moment, tending to twist the lever in one direction, will be the product of the number of units of length on the arm and the number of units of mass attached to it, and the moment tending to twist it in the opposite direction will be the product of the number of units in the other arm and the number of units of mass attached to it. In case the forces should not be acting at right angles to the arms, we must find the number of units of length in the perpendicular let fall upon the direction from the fixed point, and multiply these by the number of units of mass. What is called the principle of moments is sometimes stated thus: If two forces meet in a point, their moments with respect to any point in their resultant are equal and opposite.

The centre of gravity of a body is a point through which the resultant of the attractions on all the particles of the body passes, whatever be the position of the body. The centre of gravity of a line, circumference and area of a circle, perimeter and area of a parallelogram, sphere and cylinder should be considered. The student should also find the centre of gravity of a number of heavy particles at fixed distances from each other, and also of a thin sheet of metal in the form of a triangle.

The simple machines with the conditions of equilibrium between the power and the weight in each should be carefully prepared. These are usually pretty fully given, and involve no great difficulty.

(To be continued.)

—o—

Award of the 'Practical Teacher' School-Song Competition.

R. DUNSTAN, ESQ., has kindly acted as judge.

CLASS I. In order of Merit:—

(1) 'Don Cæsar de Bazan' (1st Prize).
WM. REES, Meliden National School, Rhyl, North Wales.

(2) 'Black Combe' (2nd Prize).
E. N. LEWIS, The Burlington Schools, Kirkby-in-Furness.

(3) 'Fidelis.' (4) 'Viola.' (5) 'Sunshine.' (6) 'Dum Spiro Spero.' (7) 'Winter.' (8) 'R.'

CLASS II. In chance order:—

'Holiday.' 'Harmonicus' 'Egroeg' 'Kettledrum.' 'Amateur.' 'Broughton Wood.' 'Little Blue Eyes.' 'Bartle Massey.'

CLASS III. In chance order:—

'I'll Try.' 'Nil desperandum.' 'King Eddlebert.' 'Merle.' 'Greyhound.' 'Hope.' 'Zo.' 'Arnen.'

CLASS IV.

Not in accordance with rules of Competition:—

'M. I. P.'

ACTION SONG FOR INFANTS.

In order of Merit:—

(1) 'Rex' (1st Prize).
R. P. GRAHAM, Board Schools, Harrington, Cumberland.

(2) 'A tempo' (2nd Prize).
EDWARD J. HAINES, Board School, Highgate, N.

(3) 'Black Combe.' Highly commended.
(4) 'Bartle Massey.'
(5) 'Winter.'
(6) 'The Captain.'
(7) 'Delta.'
(8) 'Tantsodiume.'

*** The Money Prizes in connection with the above Competition have already been paid. We hope to print the two First Prize Songs in our next issue.—ED. P. T.

Query Column.

RULES.

1. Each correspondent is restricted to *one question*. We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.

2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.

3. ☞ **When a pseudonym is adopted it should be written at the end of the query, and the real name and address on a separate piece of paper.**

4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.

5. Replies will not be sent through the post.

6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—'*The Query Editor*,' *The Practical Teacher*, *Pilgrim Street, Ludgate Hill, London, E.C.*

Algebra.

1. PRIAM.—Solve:—

(1) $2x-5y=3$, $x^2+xy=20$.

(2) $\frac{x^2+y^2}{x^2-y^2}=\frac{25}{7}$, $xy=48$.

(3) $2x+y+6\sqrt{2x+y+4}=23$.

$4x^2-6x=y^2+3y$.

(1) $\left.\begin{matrix}2x-5y=3\\ x^2+xy=20\end{matrix}\right\}$

$2x-5y=3$

$2x-3=5y$

$\therefore y=\frac{2x-3}{5}$.

$x^2+xy=20$

$x^2+x\left(\frac{2x-3}{5}\right)=20$

$x^2+\frac{2x^2-3x}{5}=20$

$5x^2+2x^2-3x=100$

$7x^2-3x=100$

$x^2-\frac{3x}{7}=\frac{100}{7}$

$x^2-\frac{3x}{7}+(\frac{3}{14})^2=\frac{100}{7}+\frac{9}{196}$

$=\frac{2809}{196}$

$x-\frac{3}{14}=\pm\frac{53}{14}$

$x=\pm\frac{53}{14}+\frac{3}{14}$

$\therefore x=4$, or $-\frac{25}{7}$.

$y=\frac{2x-3}{5}$

$=\frac{4\times2-3}{5}$, or $\frac{-\frac{25}{7}\times2-3}{5}$

$=\frac{8-3}{5}$, or $\frac{-\frac{50}{7}-3}{5}$

$=\frac{5}{5}$, or $\frac{-\frac{71}{7}}{5}$

$\therefore y=1$, or $-\frac{71}{35}$.

(2) $\left.\begin{matrix}\frac{x^2+y^2}{x^2-y^2}=\frac{25}{7}\\ xy=48\end{matrix}\right\}$

$x^2+y^2=\frac{25}{7}$

x^2-y^2

$7x^2+7y^2=25x^2-25y^2$

$32y^2=18x^2$

$16y^2=9x^2$

$4y=3x$

$\therefore y=\frac{3x}{4}$.

$xy=48$

$x\times\frac{3x}{4}=48$

$3x^2=192$

$x^2=64$

$\therefore x=\pm8$.

$y=\frac{3x}{4}$

$=\frac{\pm8\times3}{4}$

$\therefore y=\pm6$.

(3) $\left.\begin{matrix}2x+y+6\sqrt{2x+y+4}=23\\ 4x^2-6x=y^2+3y\end{matrix}\right\}$

$2x+y+6\sqrt{2x+y+4}=23$

$(2x+y+4)+6\sqrt{2x+y+4}=23+4=27$

$(2x+y+4)+6\sqrt{2x+y+4}+(3)^2=27+9=36$

$\sqrt{2x+y+4}+3=\pm6$

$\sqrt{2x+y+4}=\pm6-3$

$=3$, or -9

$2x+y+4=9$, or 81

$\therefore 2x+y=5$, or 77.

$4x^2-6x=y^2+3y$

$4x^2-6x+\frac{9}{4}=y^2+3y+\frac{9}{4}$

$2x-\frac{3}{2}=y+\frac{3}{2}$

$\therefore 2x-y=3$

$2x+y=5$, or 77

Adding, $4x=8$, or 80

$\therefore x=2$, or 20.

Subtracting, $2y=2$, or 74

$\therefore y=1$, or 37.

The values $x=20$ and $y=37$ do not satisfy the first equation.

$\therefore x=2$, and $y=1$.

Note.—(1) Each correspondent is restricted to *one* question. (2) Give the answers to your queries, and the sources from which they are obtained.

2. PICCIOLA.—Solve:—

(1) $x-y=1$, $x^2-xy+y^2=21$.

(2) $4x^2+2xy+\frac{y^2}{4}+\frac{5}{13}(4x+y)=41$,

$4x-y=4$.

(1) $\left.\begin{matrix}x-y=1\\ x^2-xy+y^2=21\end{matrix}\right\}$

Squaring, $\left.\begin{matrix}x^2-2xy+y^2=1\\ x^2-xy+y^2=21\end{matrix}\right\}$

Subtracting, $-xy=-20$

$\therefore 3xy=60$.

$\left.\begin{matrix}x^2-xy+y^2=21\\ 3xy=60\end{matrix}\right\}$

Adding, $x^4+2xy+y^2=81$

Extracting square root $\left.\begin{matrix}\\ \end{matrix}\right\}$ $x+y=\pm9$

$x-y=1$

Adding, $2x=10$, or -8

$\therefore x=5$, or -4.

Subtracting, $2y=8$, or -10

$\therefore y=4$, or -5.

$$\left.\begin{array}{l}(2)\ 4x^2+2xy+\frac{y^2}{4}+\frac{8}{13}(4x+y)=41\\ 4x-y=4\\ 4x-y=4\\ \therefore\ y=4x-4\\ \quad=4(x-1).\end{array}\right\}$$

$$4x^2+\{2x\times 4(x-1)\}+\frac{\{4(x-1)\}^2}{4}+\frac{8}{13}\{4x+4(x-1)\}=41$$

$$4x^2+8x(x-1)+4(x-1)^2+\frac{8}{13}(8x-4)=41$$

$$4x^2+8x^2-8x+4(x^2-2x+1)+\frac{8}{13}(2x-1)=41$$

$$12x^2-8x+4x^2-8x+4+\frac{10x-5}{3}=41$$

$$16x^2-16x+\frac{10x-5}{3}=41-4$$

$$=37$$

$$48x^2-48x+10x-5=111$$

$$48x^2-38x=116$$

$$x^2-\frac{19x}{24}=\frac{29}{12}$$

$$x^2-\frac{19x}{24}+\left(\frac{19}{48}\right)^2=\frac{29}{12}+\frac{361}{48^2}$$

$$=\frac{5568+361}{48^2}$$

$$=\frac{5929}{48^2}$$

$$x-\frac{19}{48}=\pm\frac{77}{48}$$

$$x=\pm\frac{77}{48}+\frac{19}{48}$$

$$\therefore\ \underline{x=2.\ \text{or}-\tfrac{29}{24}.}$$

$$y=4(x-1)$$

$$=4(2-1),\ \text{or}\ 4(-\tfrac{29}{24}-1)$$

$$=4,\ \text{or}\ 4\times-\tfrac{53}{24}$$

$$\therefore\ \underline{y=4,\ \text{or}-\tfrac{53}{6}.}$$

Note.—(1) Each correspondent is restricted to *one* question. (2) Why do you not send the answers to your queries?

3. SITOMAGUS.—A person has 200 coins, consisting of guineas, half-sovereigns, and half-crowns. The sums of money in guineas, half-sovereigns, and half-crowns are as 14, 8, 3. Find the number of the different coins.

Let x, y, z = No. of guineas, half-sovereigns, and half-crowns, respectively;

Then, $42x$ = Value of guineas in sixpences,

$20y$ = ,, half-sovereigns in sixpences,

$5z$ = ,, half-crowns ,, ,, ;

$$\therefore\ \left.\begin{array}{ll}(1) & x+y+z=200\\ (2) & 42x\times 8=20y\times 14\\ (3) & 42x\times 3=5z\times 14\end{array}\right\}$$

(2) $42x\times 8=20y\times 14$

$3x\times 2=5y$

$\therefore\ \underline{y=\frac{6x}{5}.}$

(3) $42x\times 3=5z\times 14$

$3x\times 3=5z$

$\therefore\ \underline{z=\frac{9x}{5}.}$

(1) $x+y+z=200$

$x+\frac{6x}{5}+\frac{9x}{5}=200$

$x+3x=200$

$4x=200$

$\therefore\ \underline{x=50.}$

$y=\frac{6x}{5}=\frac{6\times 50}{5}=60$;

$z=200-(50+60)=90$

$$\therefore\ \left.\begin{array}{l}\text{No. of guineas}=50\\ \text{,, half-sovereigns}=60\\ \text{,, half-crowns}=90\end{array}\right\}$$

4. MIRABILE DICTU.—Solve:—

$$\left.\begin{array}{l}x^{\frac{1}{3}}+y^{\frac{1}{3}}=1\\ x+y=19\end{array}\right\}$$ {*Military (Staff College) Examination.*}

$$\left.\begin{array}{ll}(1) & x^{\frac{1}{3}}+y^{\frac{1}{3}}=1\\ (2) & x+y=19\end{array}\right\}$$

$$\left.\begin{array}{ll}(1)\ \text{Squared} & x^{\frac{2}{3}}+2x^{\frac{1}{3}}y^{\frac{1}{3}}+y^{\frac{2}{3}}=1\\ (2)\ \text{Divided by (1)} & x^{\frac{2}{3}}-x^{\frac{1}{3}}y^{\frac{1}{3}}+y^{\frac{2}{3}}=19\end{array}\right\}$$

Subtracting, $3x^{\frac{1}{3}}y^{\frac{1}{3}}=-18$

$x^{\frac{1}{3}}y^{\frac{1}{3}}=-6$

$\therefore\ \underline{xy=-216.}$

(2) Squared, $x^2+2xy+y^2=361$

$4xy=-864$

Subtracting, $x^2-2xy+y^2=1225$

Extracting square root, $x-y=\pm 35$

$x+y=19$

Adding, $2x=54,\ \text{or}-16$

$\therefore\ \underline{x=27.\ \text{or}-8.}$

Subtracting, $-2y=16,\ \text{or}-54$

$\therefore\ \underline{y=-8,\ \text{or}\ 27.}$

$$\therefore\ \left.\begin{array}{l}x=27,\ \text{or}-8\\ y=-8,\ \text{or}\ 27\end{array}\right\}$$

5. MIRABILE DICTU.—In the equation $x^3=3px+g$, when are all the roots real? {*Military (Staff College) Examination.*}

$x^3=3px+2g$

$x^3-3px-2g=0$;

As the coefficient of x is negative, all the roots are real, when $(3p)^3$ is greater than $\frac{27(2g)^2}{4}$,

,, $27p^3$,, ,, $27g^2$,

,, p^3 ,, ,, g^2.

6. SECTION.—If α and β are the roots of the equation $ax^2+bx+c=0$, find the equation whose roots are $\alpha^{-1}+\beta^{-1}$ and $\alpha\beta$. (*Certificate, 1st Year*, 1877.)

$$\alpha^{-1}+\beta^{-1}=\frac{1}{\alpha}+\frac{1}{\beta}=\frac{\alpha+\beta}{\alpha\beta};$$

Sum of roots of equation $ax^2+bx+c=0$ is $-\frac{b}{a}$,

Product ,, ,, ,, ,, ,, $\frac{c}{a}$;

$$\therefore\ \text{Roots of required equation}=\frac{-\frac{b}{a}}{\frac{c}{a}}\ \text{and}\ \frac{c}{a}$$

$$=-\frac{b}{c}\ \text{and}\ \frac{c}{a};$$

$\therefore$ Required equation is: $\left(x+\frac{b}{c}\right)\left(x-\frac{c}{a}\right)=0,$

,, ,, ,, $x^2+\left(\frac{b}{c}-\frac{c}{a}\right)x-\frac{b}{a}=0,$

,, ,, ,, $x^2+\frac{ab-c^2}{ac}x-\frac{b}{a}=0,$

,, ,, ,, $\underline{acx^2+(ab-c^2)x-bc=0.}$

7. SOLICITOR.—Find the r^{th} term of $(a^2-x^2)^{-\frac{3}{4}}$.

$$(a^2-x^2)^{-\frac{3}{4}}$$

$$=\left[a^2\left\{1-\left(\frac{x}{a}\right)^2\right\}\right]^{-\frac{3}{4}}.$$

$$=(a^2)^{-\frac{3}{4}}\left\{1-\left(\frac{x}{a}\right)^2\right\}^{-\frac{3}{4}}$$

$$=a^{-\frac{3}{2}}\left\{1-\left(\frac{x}{a}\right)^2\right\}^{-\frac{3}{4}}$$

$\therefore$ The r^{th} term

$$=a^{-\frac{3}{2}}\left\{\frac{\frac{3}{4}(\frac{3}{4}+1)(\frac{3}{4}+2)\ldots(\frac{3}{4}+r-2)}{\lfloor r-1}\left(\frac{x}{a}\right)^{2(r-1)}\right\}$$

$$=a^{-\frac{3}{2}}\left\{\frac{3.\ 7.\ 11\ldots(4r-5)}{4^{r-1}\lfloor r-1}\left(\frac{x}{a}\right)^{2(r-1)}\right\}$$

$$=\underline{\frac{a^{-\frac{3}{2}}}{4^{r-1}}\cdot\frac{3.\ 7.\ 11\ldots(4r-5)}{\lfloor r-1}\cdot\left(\frac{x}{a}\right)^{2(r-1)}.}$$

8. ESSAYIST.—In what scale is 17486 written 212542?

Let x denote the radix;

Then, $2x^5+x^4+2x^3+5x^2+4x+2=17,486$;

The value of x will be found *by trial* to be 6;

$\therefore$ Scale is senary.

9. F. HOLTON.—If $m=x-x^{-1}$ and $n=y-y^{-1}$ show that $mn+\sqrt{(m^2+4)(n^2+4)}=2\left(xy+\frac{1}{xy}\right)$.

$$m=x-x^{-1}=x-\frac{1}{x};$$

$$m=y-y^{-1}=y-\frac{1}{y};$$

$$\therefore mn+\sqrt{(m^2+4)(n^2+4)}$$

$$=\left(x-\frac{1}{x}\right)\left(y-\frac{1}{y}\right)+\sqrt{\left\{\left(x-\frac{1}{x}\right)^2+4\right\}\left\{\left(y-\frac{1}{y}\right)^2+4\right\}}$$

$$=xy-\frac{x}{y}-\frac{y}{x}+\frac{1}{xy}+\sqrt{\left(x^2-2+\frac{1}{x^2}+4\right)\left(y^2-2+\frac{1}{y^2}+4\right)}$$

$$=xy-\frac{x}{y}-\frac{y}{x}+\frac{1}{xy}+\sqrt{\left(x^2+2+\frac{1}{x^2}\right)\left(y^2+2+\frac{1}{y^2}\right)}$$

$$=xy-\frac{x}{y}-\frac{y}{x}+\frac{1}{xy}+\sqrt{\left(x+\frac{1}{x}\right)^2\left(y+\frac{1}{y}\right)^2}$$

$$=xy-\frac{x}{y}-\frac{y}{x}+\frac{1}{xy}+\left(x+\frac{1}{x}\right)\left(y+\frac{1}{y}\right)$$

$$=xy-\frac{x}{y}-\frac{y}{x}+\frac{1}{xy}+xy+\frac{x}{y}+\frac{y}{x}+\frac{1}{xy}$$

$$=2xy+\frac{2}{xy}$$

$$=2\left(xy+\frac{1}{xy}\right).$$

10. CYMRO BACH.—Assuming that the coefficient of x^{r-1} in the expansion of $(1+a_1x)(1+a_2x)\ldots(1+a_{r-1}x)$ is the number of combinations of a_1, a_2, etc., $(r-1)$ together, find the coefficient of x^r in the expansion of $(1+a_1x)(1+a_2x)\ldots\ldots(1+a_rx)$.

Find the first three and the $(r+1)^{th}$ term of $(1-x)^{-n}$. (*Certificate*, 1883.)

Coefficient of x^r = No. of combinations of a_1, a_2, etc., $(r-1)$ together $\times a^r$

= No. of combinations of a_1, a_2, etc., (r) together.

First three terms of $(1-x)^{-n}$

$$=1+nx+\frac{n(n+1)}{1.2}x^2\ldots\ldots$$

The $(r+1)^{th}$ term

$$=\frac{n(n+1)(n+2)\ldots\ldots(n+r-1)}{\lfloor r}x^r.$$

11. BLACKBIRD.—Show that if a series of mp terms forming a geometrical progression, whose constant factor is r, be divided into sets of p consecutive terms, the sums of the sets will form a geometrical whose constant factor is r^p.

Sum of p terms, where first term $=mp$, and ratio $=r$, is

$$\frac{mp(r^p-1)}{r-1};$$

Sum of next set of p terms

$$=\frac{mpr^p(r^p-1)}{r-1},\ \text{as first term}=mpr^p;$$

$\therefore$ Sets of p terms are in geometrical progression and constant factor $=r^p$.

Arithmetic.

1. YELSSERP.—A person invests in the 3 per cents. so as to obtain interest at the rate of £2 19s. $3\frac{811}{1111}$d. per cent. per annum find the price of the stock.

£ s. d. £ £

2 19 $3\frac{811}{1111}$: 3 :: 100 : Price of stock.

20 240

59 700

12

711

809

6399

56880

801

87800

8

$=98\frac{2}{8}$£

$=$£101½. Ans.

Note.—Yes; also certificate answer.

2. TYRO.—From the first of 2 mortars in a battery, 36 shells are thrown before the second is ready for firing. Shells are thrown from both in the proportion of 8 from the first to 7 from the second. The second requires as much powder for 3 charges as the first does for 4. After how many shots will the quantity of powder consumed by the second equal that consumed by the first? (*Civil Service Arithmetic.*)

No. of shells from second mortar to equal 36 shells from first mortar $=36\times\frac{7}{8}$

$=27$;

Quantity of powder gained by second mortar over first on each discharge of second mortar

$$=\left\{1-\left(\frac{3}{4}\times\frac{8}{7}\right)\right\}\text{of charge of second mortar}$$

$=\frac{1}{7}$ of charge of second mortar;

$\therefore$ No. of shells fired from second mortar when the quantities of powder are equal

$=27\times7$

$=189$;

$\therefore$ Total No. of shells fired $=189+(189\times\frac{2}{7})+36$

$=189+216+36$

$=441$. Ans.

Note.—(1) 'How to Draw a Map,' by *A. Gardiner* (Hughes). Price 1s.

(2) 'Notes of a Course of Lectures on Commercial Geography,' by *Rev. L. C. Casartelli* (Ledsham). Price 1s. 6d.

3. HARRY.—Income tax is at present 5d. in the £, and (for smaller incomes) is levied only on the excess of a man's income over £120. After paying this tax, a man finds he has left £359 17s. 11d. What is his whole income before any deduction is made? (*Medical Preliminary Examination, Aberdeen.*)

£ s. d.

359 17 11

120

s. d. £

19 7 : 239 17 11 :: 1 : Income after deduction.

12 20

239 4797

12

87878

245

$=$£245

$\therefore$ Income $=$£245 + £120

$=$£365. Ans.

Note.—Perhaps 90 per cent.

4. X. Y. Z.—If 7 men build a wall 5½ ft. high and 1½ ft. thick about a court containing 1 ac. 1 po. 29¾ yds. in 35 days of 12 hours each, and if 53 men of equal efficiency working 14 hours a day for 180 days build a wall 13½ ft. high and 2½ ft. thick enclosing a square park, find the *area* of the park. *The area of a square is proportional to the square of the length of the side.* (*J. Brook Smith.*)

acre	pole	yards
1	1	29¾
160		
161	po.	
30½		
4859¾		
40¾		
4900	yds.	

Side of court = $\sqrt{4900}$ sq. yds.
= 70 yds.

men : men
7 : 53
ft. : ft.
13½ : 5½
2½ : 1½
dys. : dys.
35 : 180
hrs. : hrs.
12 : 14
:: 70 yds. : Side of park.

$$\text{Side of park} = \frac{\cancel{5}\cancel{3} \times 22 \times 3 \times \cancel{1}\cancel{8}\cancel{0} \times \cancel{1}\cancel{4} \times \cancel{7}\cancel{0}}{7 \times \cancel{5}\cancel{3} \times \cancel{5} \times \cancel{3}\cancel{5} \times \cancel{1}\cancel{1}} \text{ yds.}$$
$$= 792 \text{ yds.};$$

$$\therefore \text{Area of park} = \frac{792 \times 792}{30\frac{1}{4}} \text{ po.}$$
$$= \frac{\cancel{7}\cancel{9}\cancel{2} \times \cancel{7}\cancel{9}\cancel{2} \times 4}{\cancel{1}\cancel{2}\cancel{1}} \text{ po.}$$
$$= 20{,}736 \text{ po.}$$
$$= 518 \text{ ro. } 16 \text{ po.}$$
$$= 129 \text{ ac. } 2 \text{ ro. } 16 \text{ po. Ans.}$$

5. OSWALD.—Suppose a farmer has a calf, which at the end of three years begins to breed, and afterwards brings a female calf every year; and that each calf begins to breed in like manner at the end of three years. bringing forth a cow calf every year, and that these last breed in the same manner, etc.; it is required to determine the owner's whole stock at the end of 20 years. (*Bonnycastle.*)

Stock at end of 3 years = 2;
" " 4 " = 3;
" " 5 " = 4;
" " 6 " = 4+2=6;
" " 7 " = 6+3=9;
" " 8 " = 9+4=13;
" " 9 " = 13+6=19;
" " 10 " = 19+9=28;
" " 11 " = 28+13=41;
" " 12 " = 41+19=60;
" " 13 " = 60+28=88;
" " 14 " = 88+41=129;
" " 15 " = 129+60=189;
" " 16 " = 189+88=277;
" " 17 " = 277+129=406;
" " 18 " = 406+189=595;
" " 19 " = 595+277=872;
" " 20 " = 872+406=1278.

6. W. R. GATENBY.—In an election of a member of Parliament $\frac{1}{10}$th of the constituency neglected to vote, and of two candidates the one who is supported by $\frac{19}{20}$ths of the whole constituency is returned by a majority of five; find the number of votes for each.

The unsuccessful candidate is supported by
$\{1-(\frac{19}{20}+\frac{1}{10})\}$ of the constituency
$=\left(1-\frac{38+5}{80}\right)$ " "
$=\frac{37}{80}$ " " ;
$\therefore (\frac{19}{20}-\frac{37}{80})$ of the constituency = 5,
$\frac{38-37}{80}$ " " = 5,
$\frac{1}{80}$ " " = 5,
$\therefore$ The constituency = 400;
No. of votes for the successful candidate = $\frac{19}{20}$ of 400
= 190,
" " " unsuccessful " = 185.

General.

1. INFELIX.—The numbers 3 and 5 are the smallest odd prime numbers (excepting unity), and the smallest quotients give the largest divisors.

2. BLACKBOARD.—You will find one method of solution of your query in our issue for May, 1883, and another method in our issue for March, 1882.

3. FAIRLY CAUGHT.—The four pieces into which the square is divided do *not* form an oblong. The figure *appears* to contain 65 of the small squares; but if you examine it carefully, you will find that some of the squares are *incomplete*. The 64 small squares could *not* become 65.

4. E. H.—We believe you have given your query *incorrectly*. Would you please repeat it, and send (if possible) the answer?

5. R. OWEN.—(1) You will find a full reply to your query in our issue for November, 1882. (2) 'The Science and Art Directory' may be obtained through any bookseller; price sixpence.

6. DETERMINED.—Action songs of the kind you mention are rather difficult to obtain. Try 'Action Songs for Children,' by *Clifft Wade* (J. Heywood); *Miss Heerwart's* 'Songs for the Kindergarten' (Boosey and Co.), and see advertisements in the PRACTICAL TEACHER and other educational publications.

7. C. F. HAYWARD.—WHAT — WHAT, like the Latin *qua—qua*, is used for PARTLY—PARTLY. See *Abbott's* 'Shakesperian Grammar,' par. 255. Hence WHAT in this case is a correlative adverb.

8. MAGISTER.—Your query was sent by another correspondent, and the solution appeared in our *last* issue.

9. EVENTIDE.—Your query was solved in our issue for November, 1883.

10. FLOWER.—'Follow conscience, come what may.' Compare
'Faites ton devoir, advienne que pourra.'
Hence 'come' may be taken as a subjunctive or imperative, what may (come) being an adjectival clause.

11. BRIDLINGTONIAN. — *Morris'* 'Elementary Lessons in Historical English Grammar.' Macmillan and Co., 2s. 6d., page 27.

12. NANCE.—(1) No. (2) No. As to the sewing, you had better write to the Secretary of the College you intend going to. (3) No one would like to answer. Read Fitch's Lectures, and the Manuals by the National Society.

13. SCIENCE.—*Tanner's* 'Elements of Agricultural Science,' published by Macmillan and Co.; not dear.

14. LEO.—Yes, decidedly.

15. A SUBSCRIBER.—The Fifth Year's Pupil Teachers' Examination. No limit as to age.

16. QUÆSITA.—Writing, large hand and medium both need much care. Study some really good copies; 60. Small hand fairly good; 70. You cannot get an answer to your question. The 'class' is not regulated by success in one subject. Men have got high up in the 1st class who have taken no language but English; but then they have had a science or two to help them; these count for more than grammar and geography.

17. ANXIOUS ONE.—(*a*)

Sentence.	Kind of Sentence.	Conn.	Subject.	Predicate.	Object.	Extn.
(*a*)						
The boy stood on the burning deck	Princ. S.		The boy	stood		on the burning deck (*place*)
(*b*)						
Whence all but him had fled	Adj. Sen. to (*a*)	*whence*	all but him	had fled		whence (*place*)

(*b*) Battersea, Chelsea, Borough Road, Westminster, Cheltenham, and Saltley, often alternate. No precise order can be given, though the foregoing may be taken as the usual order.

18. RIVER DEE.—Large hand, 40; and small hand 50 per cent.

19. ASSISTANT.—Yes. Number one, 40; number two, 45; both bad.

20. B. M. TRAPP.—*Deschanell's* 'Natural Philosophy Volume on Sound and Light,' or any good book on acoustics.

21. H.—The papers will all be published as they were read, and will shortly be for sale.

22. LIZZIE.—

Sentence.	Kind of Sentence.	Conn.	Subject.	Predicate.	Object.	Ext. of Pred.
But my soul wanders (*a*)	Princ. S.	But	My soul	wanders		back
I demand it back to, etc. (*b*)	Princ. S. *co-ord. with* (*a*)		I	demand	it, to meditate amongst decay and stand a ruin amidst ruins, there to track fallen states and buried greatness o'er a land	
which was the mightiest (*c*)	Adj. Sent. to (*b*)		which	was the mightiest		in its old command
and is the loveliest (*d*)	Adj. Sent. to (*b*)	and	(which)	is the loveliest		ever
and must ever be (*e*)	Adj. Sent. to (*b*)	and	which	must be (the loveliest)		
(It is) the master-mould of Nature's heavenly hand ∫	Princ. S.		It, *i.e.*, the land,	is the mastermould of Nature's heavenly hand		
Wherein were cast the heroic and the free, the beautiful, the brave, the lords of earth and air (*f*)	Adj. Sent. to ∫		The heroic, and the free, the beautiful, the brave, the lords of earth and air	were cast		wherein

23. 1ST B.A.—If the angle be given, the sin, cos, and consequently the tan, can be found from the Trigonometrical Tables of Natural Sines and Cosines. Consult *Chambers'* 'Mathematical Tables.'

The sin, cos, etc., of angles of 15°, 30°, 45°, 60°, 75°, etc., are given in works on Plane Trigonometry.

24. FRED.—We do not, at present, intend to continue the Lessons. Write to Messrs. Sonnenschein and Co. for a prospectus of the Rev. E. Fowle's Latin Books. They are excellent.

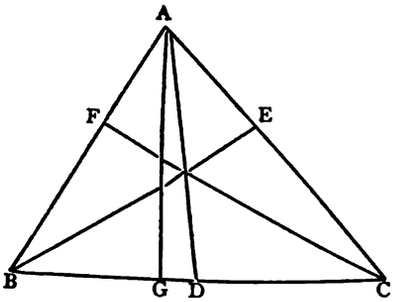
Geometry.

1. BOLDMERE.—Show that three times the sum of the squares on the sides of a triangle is equal to four times the sum of the squares on the lines drawn from the vertices to the middle points of the opposite sides. (*2nd Stage Mathematics*, 1884.)

Let ABC be a triangle, and let the three straight lines AD, BE, CF be drawn to the middle points of the opposite sides.

Then, $3(AB^2+BC^2+AC^2)=4(AD^2+BE^2+CF^2)$.

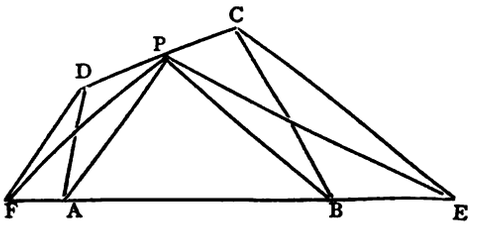
Draw AG perpendicular to BC.



Proof.—$AB^2=AD^2+BD^2-2BD.DG$, (II. 13.)
$AC^2=AD^2+CD^2+2CD.DG$, (II. 12.)
$\therefore\ AB^2+AC^2=2AD^2+2BD^2$; (Ax. 2.)
$2(AB^2+AC^2)=4AD^2+4BD^2$
$=4AD^2+BC^2$;
Similarly,
$2(AB^2+BC^2)=4BE^2+AC^2$,
$2(AC^2+BC^2)=4CF^2+AB^2$;
$\therefore\ 4(AB^2+BC^2+AC^2)=4(AD^2+BE^2+CF^2)+AB^2+BC^2+AC^2$,
Wherefore $3(AB^2+BC^2+AC^2)$
$=4(AD^2+BE^2+CF^2)$. (Ax. 3.)
Q. E. D.

Note.—Messrs. Longmans and Co., Paternoster Row, E.C., publish an excellent work on the subject.

2. E. H. COUMBE.—ABCD is a given quadrilateral: construct a triangle whose base shall be in the same straight line as AB, vertex at a given point P in CD, and area equal to that of the given quadrilateral. (*Todhunter.*)



Join PA, PB. Through C draw CE parallel to PB, and meeting AB produced at E.
Through D draw DF parallel to PA, and meeting BA produced at F.
Join PF, PE.
Then PFE shall be the triangle required.
Proof.—$\triangle PEB=\triangle PCB$, (I. 37,)
And $\triangle PFA=\triangle PDA$; ,,
$\therefore\ \triangle PFE=$Quadrilateral ABCD.
Q. E. F.

*** *Many Queries are unavoidably held over.*

The International Conference on Education.

THE International Conference on Education, recently held in connection with the Health Exhibition, was a remarkable and notable gathering, and reflects much credit upon Lord Reay, the President, and his colleagues, the members of the Committee. Never before, perhaps, was brought together such an array of educational talent, and certainly on no previous occasion have the various phases of educational thought been so clearly, fully, and forcibly presented to the public mind. Scarcely a branch of popular instruction was left untouched. University training, the education of women, physical educational, technical education, art education, the various branches of elementary education down to the Kinder-garten, free

education, compulsory education, school buildings, and school hygiene were all freely and fully discussed. Papers on these and other topics were read by experts most competent to give reliable information thereon, and most interesting and valuable debates arose in every section. With the space at our disposal it is impossible to give even an outline of the proceedings. All we can do, therefore, is to present to our readers a few of the prominent points discussed, leaving them to study at leisure the full report which will shortly be issued by the authorities of the exhibition.

The Conference was fortunate in having for its president a man so capable in every respect as Lord Reay. Of him it may be said even more truly than of Cobden, that he is an 'international' man; and this, combined with his wide knowledge and high intelligence, pre-eminently fitted him to preside over an International Conference on Education. Though known to English public life for a comparatively short period of time, Lord Reay has, since his appearance as President of the Social Science Congress in 1880, rapidly made his way to the front rank as an educationalist and social reformer. His opening address was in many respects a remarkable one. With the Lord President in the chair, and surrounded by a galaxy of educational notabilities, among whom were the American Minister, Mr. Mundella, and the Chairman of the London School Board, he delivered an inaugural address which was as brilliant as it was erudite and comprehensive. Taking his tone naturally from his surroundings, he indicated that a new departure was about to be made in English education, in which the cultivation of the observing faculty would have an important place. Upon this point it may be well to quote his lordship's words:—

'Constant observation of the various forces which are operating is the main element of education. The development of the powers of observation to satisfy an ever-expanding curiosity is at the root of every system of rational education. How to observe, and what to observe, in the past and in the present, is the ever-recurring function of education through life. Apply the test to the humblest and to the most exalted professions, you will see that the test does not fail. The agricultural labourer, whose work is of the most interesting description, will be efficient or inefficient, exactly in proportion as his faculty of observation has been developed. Nature will teach him something every day of his life, if he has been taught how to watch her workings. It is the same for the astronomer; observation is to him the first necessity. In primary education, this truth is more and more recognised; and drawing, as well as elementary science and manual work, are being put in their proper places. Belgium is moving vigorously in that direction, following, with reference to manual work, Sweden, where the *slöjd*, or school of domestic industry, may well claim our attention. Two French Ministers of Education, M. Bardoux, and the present Premier (M. Ferry), have given their verdict in favour of the extreme importance of drawing. Sweden also contributes to gymnastics that efficiency of training which—as we are so near to hygienics—I need only indicate with a word. The monopoly of the three R's is doomed, and the enthronement of the three D's—drawing, drill, and adroitness—approaching. The primary school must not degenerate into a mere workshop. I do not agree with the Procureur-Général de la Chalotais when he complained of the subversive influence of the Jesuits in teaching children to read and write, who ought only to learn how to handle a hammer or a plane. In pleading for rational being substituted for mechanical methods, I simply desire to rouse inquisitive tendencies, which, in many cases, now are deadened: to make the primary school, not the early grave of individuality, but an attractive spot where the productive use of leisure as well as of the hours devoted to work, coupled with the surroundings of prints and flowers, shall give pleasure to the boys and girls who frequent it.'

He agreed that through technical education we must recover the ground lost since the Middle Ages, when, in Italy at least, an artizan was an artist. There must be a large increase of schools with a modern curriculum. His lordship protested against too much centralisation in education, and viewed with some suspicion the idea of a Minister of Education. He thinks, that 'if every nation were to give full play to the variety of talents which it contained, instead of trying to press their schools into one mould, we should hear less complaint of want of originality.' The Universities were called upon to take their share in the coming reforms. If they gave us our lawyers, our doctors, our statesmen, our clergy, and our literary men, why should they not give us the best engineering, financial, agricultural, and commercial skill? He urged that the University of London should become a teaching university, and that the Technical College should be affiliated to it. We cannot better conclude our notice of Lord Reay's address than by giving the following quotation:—

'Such complex machinery as modern society, with its manifold wants, makes the organisation of education more complex every day. Not by centralisation, not by programmes, not by circulars, not by examination papers, not even by lavish expenditure alone will success be attained. What is wanted is that public spirit, that strong conviction in every man, woman, and child, that education is a privilege; that the more education a man has the more he is to be respected. Does it exist? Yes, you will find among the scattered population of the Highland glens of Scotland and of Switzerland, along the canals of the Netherlands, in the forests of Germany. It is a precious heritage. To increase it is our object. The great Chancellor of the German Empire once compared the struggle for gold between the central banks of Europe to a struggle among individuals for a blanket of insufficient size. The same process is at present going on in various States of Europe with reference to education. We are all struggling for golden wisdom, with this great difference, that the gold we bring to the surface at once becomes the property of all. The discoveries of the biological marine station at Naples can be tested at St. Andrews, and the scientific work done at Strasbourg can be utilised in Edinburgh. Science cannot render men equal. The princes of science constitute a separate order, and when we enjoy the pleasure of contemplating or reading the works of genius, we cannot help admitting our own inequality. A nation ceasing to reverence its great men is on the decline. Inequality is a law of nature; but so is liberty, and liberty is incompatible with equality. But if education alone makes liberty possible, by learning its uses and preventing its abuses, it also teaches us to be generous. The best educated man will also have the widest sympathies. The best educated people will also be the people which cements peace and goodwill among nations.'

The international character of the Conference will be seen from the list of foreign representatives who were entertained at the Mansion House Banquet by the Lord Mayor, M.P. The five Departments of the French Ministry of Public Instruction were represented by sixteen delegates, and no less than eleven upheld the honour of Belgium. Austria and Saxe Weimar sent representatives, as did also Russia, Spain, Denmark, Holland, Switzerland, The United States, Brazil, and Japan. The able speeches of Messieurs Buls (Burgomaster of Brussels), Buisson (Director of Primary Instruction in France), Lanholt (Inspector of Secondary Schools in Berne), and other foreign delegates, gave a completeness and breadth to the discussion which was most satisfactory.

After the inaugural address, the work of the Conference was transacted in four sections. In Section A, most of the proceedings had reference to Elementary Education, and during the greater part of the Conference this section attracted the largest attendance. Papers on the 'Structure, Fittings, and Equipments

of a School' were read by the Vice-chairman of the Birmingham School Board and others.

The discussions in Section A on Tuesday were of a highly interesting character, the subject being 'Infant School Education.' Mr. Fitch presided, and papers were read by Miss Manning on 'What Fröbel did for Young Children,' and by Fraulein Heerwart on 'The Kinder-Garten in Relation to the various Industrial Products of a Country.' A paper promised by Madame Schrader, of Berlin, was not forthcoming. The advocates of the Kinder-Garten system had quite a field-day, the papers being thoughtful and judicious. Mr. Fitch closed the discussion in a careful and temperate speech, which was not marred by the extreme and fantastic enthusiasm of many of those who speak of Fröbel and the Kinder-Garten without any real appreciation of the true spirit which animated him and his work. In the afternoon Mr. Woodall, M.P., presided in this section, when the following papers were read: 'Infant Schools under the Code of 1884,' by Mr. A. Bourne: 'The Apparatus Needed for Play and Instruction,' by Miss Ellis; and 'Infants' Schools in France,' by Madame Dillon, Inspectress of Infant Schools in France. A demonstration lesson was afterwards given to a class of infants by Fraulein Heerwart in room No. 12. Here we found the true teacher shining orth in every word and action of the demonstrator, and we came away confirmed in our belief that it is not a 'system' that we require, but Fröbels and Heerwarts.

On Wednesday this section was presided over by the Vice-President of the Council, when a trenchant paper was read by Mr. Heller, of the London School Board, on the 'Organisation of Elementary Education.' In this paper Mr. Heller, while acknowledging the enormous advance made during the past thirty years, points out the principal defects in the present educational arrangements of the country, and indicates certain reforms. He stated that 'the system of remitting fees in the Metropolis was doing more to encourage hypocrisy, and to demoralize the working classes, than any recognised system of free schools could possibly do.' He argued that the system of training teachers should be so modified that teachers 'should obtain their general education in the same manner, and to the same liberal extent, as the lawyer, the doctor, and the divine,' and that the Training Colleges should be affiliated to the Universities and made more strictly professional in their work and functions. An interesting historical sketch of Primary Education, read by the Rev. H. Roe, calls for no special comment. The discussion which followed was animated and instructive. Mr. Mundella, as became the official head of the Education Department, took a more roseate view of matters educational than did Mr. Heller, and he demurred to the conclusions at which the latter had arrived from the Department's statistics on school attendance. The Vice-President then ventured into Utopia, and sketched an ideal condition of education in England. He agreed with most of the reforms sketched out by Mr. Heller, but he feared it would be a long time before they could all be realized.

During the discussions in Section A, it was curious to note how nearly every speaker reverted to the question of 'Overpressure in Education.' Mr. Heller had barely referred to it, having apparently studiously avoided introducing a confusing element into the question of 'Organization.' Mr. Sydney Buxton, M.P., however, rushed into a controversy on overpressure, which had nothing to do with the question before the Conference, and about which the honourable gentleman did not appear to be very well informed. Miss Edith Lupton, of Bradford, followed the same lead, and spoke in her characteristically fervid and fluent style, which seems to have completely defeated the frantic efforts of the reporters to keep pace with her utterances. So keen was the interest taken in this discussion, that the Section resumed it in the afternoon instead of devoting the time, as had been intended, to a half holiday. Messrs. F. White, Collins, Kennedy (Glasgow), and others took part in the proceedings, as did also Mons. Buls, of Brussels, who read a paper on 'Conditions of Healthy Education.' In moving a vote of thanks to Mr. Mundella, Mr. Heller caused some amusement by referring to 'the very conservative tone of the Vice-President's remarks.'

In Section B the subject of Technical Education was dealt with. Mr. Mundella presided on Monday, when Mr. Philip Magnus, one of the Commissioners, delivered an introductory address. Mr. E. M. Dixon, of the Allan Glen's Institute, Glasgow, read a paper on 'Workshop Instruction in Technical Schools,' and Mr. J. F. Moss expatiated on 'Technical Teaching in Board Schools.' The former paper described how technical and scientific instruction were combined in the Allan Glen's Institution, and indicated some of the results of the teaching, which were further illustrated by the models made by the scholars and shown in the Health Exhibition. Mr. Moss described an experiment tried in the Central Higher Board School, Sheffield, and his communication was full of interesting and accurate information. A paper on 'Manual Training Schools,' by Professor Woodward, of St. Louis, was circulated, but not read. A general agreement seemed to exist that some manual training was desirable, but the speakers differed greatly as to how far such teaching could be introduced into the primary school. The remarks of Mr. Park and of Mr. Woodall were eminently practical, and were in the direction of not too soon disturbing and specialising the general education of the scholars. On Tuesday Prof. Armstrong opened a discussion on 'Instruction in Chemistry,' and Professor Garnett read a paper on 'Technical Education.' A very animated discussion followed, in which the work of the Science and Art Department was criticised, and the system of 'Payment by Results' was condemned. In the afternoon Mr. Harrison, of Birmingham, gave an account of 'A New Method for the teaching of Science in Public Elementary Schools.' The method is a very simple affair, and consists of an itinerant lecturer and a locomotive laboratory. The cost is shown to be comparatively small, and we have no doubt that much good scientific instruction may be thus provided. But we agree with Professor Armstrong that 'if science is to be taught at all, it must be done seriously.' If it is taught peripatetically, the instruction can never become practical. Mr. H. A. Reatchlous, of the Westminster Training College, read a paper on 'Science Teaching in Training Colleges,' in which he defended those institutions from the charges of inefficiency which the Commissioners had brought against them. He pointed out with perfect fairness and much force: (1) That science can only be taught in training colleges as one of many equally important subjects.

(2) That sound elementary instruction is being given in these institutions at the present time. (3) That the success of the students in chemistry, and especially in practical chemistry, is inconsistent with the judgment expressed by the Commissioners on page 526 of their report. (4) That further improvement must be sought in giving the men greater inducements to work practically at the subject themselves, and study phenomena at first hand. The discussion which followed did not in any degree shake the position taken up by Mr. Reatchlous.

The teaching of cookery was dealt with in the same section by Miss Fanny Calder, and a very interesting discussion followed. On Wednesday the section was devoted to art. Mr. Sparkes, of South Kensington, Mr. Ablett (London School Board), and Mr. Brophy (Finsbury Technical College), read papers on 'The Teaching of Drawing and Colouring as a Preparation for Designing and Decorative Work.' The papers contained very valuable suggestions, which will bear fruit in the future. Perhaps no men could have been found more competent to propound opinions on this subject, which is so closely connected with our manufacturing interests. Mons. Couvrier, on behalf of M. Germain, read a paper 'On the Teaching of Domestic Economy and Needlework,' in which, while declaring that 'it is a great mistake to turn primary schools into technical schools for preparing children for various trades,' he advocated distinct teaching in domestic economy and needlework.

We would willingly extend our notice to the work of the other sections, in which the 'Training of Teachers' and 'University Education' were dealt with, and similarly, we should much like to notice the excellent paper by Mr. Fitch on 'The Examination and Inspection of Schools,' but the pressure upon our space forbids. We may be able to return to the subject on a future occasion, and thus place before our readers a complete resumé of the proceedings of this memorable conference. The transactions, when published, will be a source of constant reference, and will furnish for some time to come a valuable amount of information on current educational topics. We trust the success of the conference may lead to similar meetings at no far-distant date. The arrangements made by Mr. Cowper, the Secretary, were excellent.

The Discipline of the Mind.

BY W. C. COUPLAND, M.A., B.SC.,

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V.—IMAGINATION.

THE due control of Imagination is not the least difficult of educational problems. In no part of the mental economy is the golden mean so important to attain or so easy to miss. For, on the one hand, an active imagination is the mainspring of spiritual progress, on the other an unseasonable and too luxurious fancy infallibly relaxes moral fibre, and dims the clear eye of reason.

There is both truth and error in the vulgar opinion that Imagination is most brilliant in the infancy of the individual and the race. There is truth in the statement in so far as the mental picturing of individual wholes precedes the power of framing general conceptions. The logic, it has been said, of animals and of young children is that of Images; by which is meant that the earliest associations are formed between concrete wholes, as given in sensuous experience, and that these spontaneous associations dominate the spiritual life, until the individual has acquired the power of arbitrary selection and rejection among the constituents of consciousness. Perception, Imagination, Conception, are the three stages of conscious life. The first reaches back to the very dawn of animal existence, the second marks out the 'higher' animal, the third is characteristic of Man. Now, as the order in which faculty has been evolved is an order determinative of its future manifestation, a scientific discipline should give heed to the hints of spontaneous growth, and further the unfolding of each power in its season.

But it will be well at once to rightly understand the force of this term 'Imagination,' for its ambiguous employment has been the source of much theoretical, if not practical, confusion. There are, indeed, two senses partially opposed to each other in which it is employed; it being equivalent either to the internal re-view of a concrete whole after the object has been withdrawn from direct perception, or to the rearrangement of the elements of former experiences, with a view to the satisfaction of some particular emotion. Now it is when employed in the former sense that the assertion is correct that primitive peoples are highly imaginative, more imaginative even than the civilised moderns. And naturally so, for not having acquired the art of condensing a vast host of particulars into the unity of a general idea—an art requiring the aid of conventional symbols, as words or written signs—the retention of serviceable knowledge necessitated in early times the constant inner visualizing of the past, and a pictorial memory was essential even to self-preservation. The same rule of procedure obtains in the development of the young child. The will being yet non-existent or embryonic, the child can think only by media which require no effort for their production, and which are little else than the pale traces of its fuller life. Accordingly it is all-essential that the thought-images should be *faithful*, that is, that they should truly represent what erewhile was direct, sensuous presentation. With many this power will need no assistance; the actual scenes will be so sharply photographed, as it were, upon the sensitive plate of the brain, that a very weak illumination of the interior light will enable the idea to be realized in almost its original brilliancy. In other cases, however, the faculty will have to be assisted; when either the representative power itself is fundamentally weak, or the internal stimuli to its exercise are few and of low intensity.

Now, when it is said that early nations are most imaginative, that the present age is un-ideal, that the fancy of children is superior to that of adults, the assertion can only be allowed to pass if held to mean, that the reproductive or pictorial imagination occupies a larger relative space in the life of certain periods than other modes of mental activity, and that as time goes on the 'Logic of Signs' comes to supersede the Logic of Sensuous Images. But it would be erroneous to use this language of that other species of Imagination, where the activity of the mind is occupied in framing conceptions which are not abstracted from the superficial aspects of the real world. In *this* sense savage

races and youthful minds must, on the contrary, be pronounced highly unimaginative, for the want of this power is probably the main reason why the life of primitive generations revolves in so monotonous a round, and why the old head is not found on the young shoulders. For it is implied in this other and higher sense of imagination that the mind at a certain stage has a power not only of re-casting objects and scenes once beheld, but of penetrating beneath the surface of things, and of putting itself in the position of people whose modes of consciousness it has no means of directly gauging, which again requires a very large experience and a great diversity of social life.

We must, then, clearly distinguish these two varieties of the imaginative faculty, or we shall be led astray in our disciplinary methods, and endeavour to produce results which by the nature of the case are unattainable.

Having uttered this preliminary word of warning, however, I am by no means disposed to lay an extreme stress upon the distinction just drawn. The *reminiscent* and the *re-constructive* imagination are after all not easily divisible, and in the actual operations of consciousness it is the rule rather than the exception to find them in combination. Thus the shaping hand of Art interferes with the simple flow of spontaneous association, and a certain transposition of the details may falsify what seems the simple revival of the bygone. We see the germs of a tendency to transcend the actual in the spontaneous manifestation of the 'play-instinct.' Here the incidents which have excited wonder or admiration, but which, perhaps, have been no part of the child's own active life, are on the first opportunity enacted in the play-theatre, and that selectiveness which is characteristic of Art in all its forms is exhibited in the pigmy mimicry and dramatization of the infant's æsthetic world. An equally good example would be the strong tendency to 'day-dreaming' exhibited by many youthful minds, where, out of a very small stock of actual experiences, the mind goes on to construct pictures and work up scenes more gorgeous than anything it is ever likely to behold with the bodily eyes.

Now what must be said with regard to this splendid power in an educational point of view is this, that both forms of imagination, the reproductive and productive, are to be cultivated to the highest pitch, but to be kept to their places, and held to do work which is profitable to the life of the human being *as a whole*. As the variety of actual experience open to the most favoured human being is after all insignificant compared with possible experience, a power of rapidly utilizing the few forms of actual experience vouchsafed it, to construct a world beyond the reach of personal perception, is the prime condition of intellectual growth. And the forms of existence being so varied, it is extremely improbable that a power of imagination in all directions will be possessed by any mind. There will always be some direction in which the ability to call up mental pictures will be weak. There is a spontaneous constructive power in all, which should be detected by the educator, desirous of estimating the bent of character with a view to proportioning discipline to power. Imagination as concrete memory runs in channels pleasing to the individual, and to see the drift of the current we must watch its subtle windings in recreative moods, when the mind is abandoned to itself, and no constraint is imposed from without. What dreams are to the individual desirous of self-knowledge are the trivial games and sports of fancy to the philosophic educator and the possible successes and perils of the future may be read by a discerning eye in both.

There may be said here what admits of application to the whole range of mental culture, that not *repression* but *direction* is the *rôle* of the scientific educationist. The Imagination cannot be too active, if only it be an imagination which furthers the real work of life. The misfortune, however, is that many of tis manifestations are hostile to the welfare of the individual and of society. There is no harm, nay, there may be much good in stimulating the imagination of very young minds by stories of impossible triumphs over physical obstacles and of feats of unlimited personal prowess. Human nature speedily gravitates to a low estimate of its capacity, and needs to be roused by ideals of excellency rising above the actual environment. Fiction, if merely transcending not distorting the actual, whilst with some a spontaneously sought indulgence is for others a needed incentive. The fairy-tale and the romance are aids to culture which only a narrow-souled disciplinarian, confounding matter-of-fact truth with truth of life, will despise. Now Nature bends to the touch of mind, and man is bidden to have courage in presence of the dark fate which seems at the first blush utterly to enfold him; now the fairest hopes and most cherished desires of the heart attain a fruition which, if illusory, counts for much as a spur to strenuous exertion.

But the mind having had its dream of beauty, the careful trainer will see to it that the dream does not outlast the hour of repose, and will supply more practical material for the plastic energy of the working-day. The difference between the Imagination which enervates and unstrings the powers, and the Imagination that gives breadth and grasp of truth, lies in this, that the former is a mere revelling in the pleasing aspects of things superficial in obedience to the associative impulse alone, the latter is a synthesis born of deep-seated emotion, following on a genuine analysis. In the one case we are at the mercy of our fortuitous associations, the combinations are like dissolving views, gladdening for the moment, but becoming no part of our spiritual fabric; in the other they are extensions of common life, which we ourselves have helped to fashion. It is immaterial to what department of mental activity we turn, what the nature of the constructions may be, if they are to enrich us and to add to our power they must be the result of an *active* synthesis, they must be truly original in the sense of being the outcome of a vital will. This holds true even of Art strictly so called. No work of Art has ever powerfully affected mankind where hard labour has not been spent in mastering the elements which enter into the composition, where there has not been a synthesis, the secret springs of which perhaps are hidden, but which has its source in the core of the artist's own soul. Where there is not this personal activity the production may be rich in conceits of fancy, but will leave the spectator unmoved. But the world of Imagination must of course not be limited to the artistic sphere; its exercise is just as much required, and just as evident, in the region of practice or in the realm of pure theory. A high constructive imagination, the power, that is, of rising out of the rut of routine, of bringing experience to bear upon

novel situations, of devising new methods to cope with emergencies, is a faculty which has no slight scope for its exercise in every-day affairs; and the *scientific* imagination may claim at least equality with that which forms the glory of the poet. Few ideas, indeed, are more mistaken, and may prove more mischievous, than the notion that Imagination is either a useless or a frivolous exercise of mind. Not useless, for it is the lack of it that condemns a mind or a nation to spiritual and material stagnation; frivolous only when divested of a high purpose.

(*To be continued.*)

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Chemistry of the Non-Metallics.

BY EDWARD AVELING, D.SC. LONDON.

[This series of articles, whilst dealing with the subjects required by the University of London for the Matriculation Examination and with those required at the Elementary Stage of the Inorganic Chemistry (Branch X.) Science and Art Department, is intended as a practical guide to the philosophical and systematic study of the non-metallics.]

EXAMPLES ON THE FORMATION OF HYDROGEN FROM WATER AND POTASSIUM OR SODIUM (*for Solution*).

(21) Required 7 grams hydrogen. What weights of water and sodium must be taken? ..... 126 and 161 grams.

(22) What weight of water will 2 grams of potassium decompose? ..... $1\frac{1}{2}$ grams.

(23) 9·2 grams sodium are thrown on water. What weight of hydrogen is evolved? ..... $\frac{1}{5}$ gram.

(24) What weight of caustic potash can be formed from 1 litre, 8 hectolitres of water? .....
3 kilog. 7 hectog. 3 decag. $3\frac{1}{3}$ grams.

EXERCISES (*Solved*).

(32) 5·6 litres hydrogen are required. What volume of water and what weight of sodium are needed? .....
22·4 litres H. require 36 grams = 36 cc. H^2O + 46 grams Na.

1 ,, requires $\frac{36}{22\cdot4}$,, = $\frac{36}{22\cdot4}$,, ,, $\frac{46}{22\cdot4}$,, ,,

5·6 ,, require ,, ,, = $\frac{36\times5\cdot6}{22\cdot4}$,, $\frac{46\times5\cdot6}{22\cdot4}$,,

9 grams water, $11\frac{1}{2}$ grams sodium.

(33) 7·8 grams potassium are given you. What volume of hydrogen can be obtained by the action of these upon water?
With 78 grams K. 22·4 litres H. can be obtained.

,, 1 gram ,, $\frac{22\cdot4}{78}$,, ,, ,,

,, 7·8 grams ,, $\frac{22\cdot4\times7\cdot8}{78}$,, ,,

2·24 litres.

EXAMPLES (*for Solution*).

(25) 800 cc. hydrogen are required. What weight of sodium must be taken? ..... $1\frac{5}{13}$ grams.

(26) From $\frac{1}{2}$ litre of water what volume of hydrogen can be obtained? ..... $311\frac{1}{9}$ litres.

From the experiments of water and sodium or potassium another general truth may be learned. By reference to page 260, the student will see that whilst the water before the metal was thrown upon it did not affect either the red litmus paper, the blue litmus paper, or the yellow turmeric, after the experiment the blue litmus paper was still unaffected, the red was turned blue, and the yellow turmeric paper brown. These changes are due to the action on the vegetable colours of the potassium hydrate or sodium hydr ate formed in the reaction. Each of these compounds has the power of turning red litmus paper blue, and yellow turmeric paper brown. Bodies possessing this power are called alkalies. Their solutions are spongy to the touch. This can be rectified by feeling the water in the trough, after the potassium or sodium has been thrown into the water.

If three similar pieces of paper are placed in sulphuric acid the blue litmus paper is turned red, and the others are not affected. Bodies possessing this power are called acids. Their solutions are sharp to the taste.

If a solution of caustic soda or potash and the sulphuric acid are mixed together carefully with frequent testing by litmus papers, it is found that they neutralise the action one of the other, and that at last a solution is formed that is neither alkaline nor acid. That solution contains a salt, sodium or potassium sulphate.

$$\underbrace{2\,NaHO}_{2(23+1+16)\,=\,80} + \underbrace{H^2SO^4}_{2\times1+32+4\times16\,=\,98} = \underbrace{Na^2SO^4}_{2\times23+32+16\times4\,=\,142} + \underbrace{2\,H_2O}_{2(2\times1+16)\,=\,36}$$

$$\underbrace{2\,KHO}_{2(39+1+16)\,=\,112} + \underbrace{H^2SO^4}_{(2+32+64)\,=\,98} = \underbrace{K^2SO^4}_{78+32+64\,=\,174} + \underbrace{2\,H^2O}_{2(2+16)\,=\,36}$$

THIRD PREPARATION. FROM WATER BY ELECTRICITY.

(1) *Laboratory Method.*—Place in a pneumatic trough a quantity of water; and add a few drops of sulphuric acid to the water. Arrange two gas-jars inverted and filled with the acidulated water upon two beehives. Attach to the two end plates of a Grove's battery two copper wires. To the wire attached to the platinum plate of the battery affix, at its free end, a piece of platinum foil. The reason for doing this is that the gas, oxygen, that will be given off at this wire will combine with the copper wire, and not be liberated. Place the free ends of the two wires in the acidulated water, and slip them through the side apertures under the beehives upon which the inverted gas-jars are standing. Bubbles of gas are slowly disengaged at each wire-end. The water is decomposed; the gas which comes off at the end of the wire connected with the zinc plate of the battery is hydrogen.

This experiment introduces us to the electrical relationships of chemical compounds in general, and of water in particular. Every chemical compound is made up of two groups, sometimes consisting of one element, sometimes of more than one. Of these two groups one is electrically positive, the other electrically negative. In the case of water the hydrogen is positive, the oxygen negative. By a well-known law of electricity, bodies electrified in opposite ways attract; bodies similarly electrified repel one the other. The free end of the wire connected with the zinc plate is electrically negative, and therefore at it the positive hydrogen comes off. The free end of the wire connected with the platinum plate is electrically positive, and therefore at it the negative oxygen comes off.

As in water there are, as the symbols of that compound remind us, two parts by volume of hydrogen to one of oxygen, the jar above the negative wire-end or pole ought to fill twice as rapidly as that over the positive pole. But this is not what occurs. For oxygen gas is much more soluble in water than in hydrogen, and a great deal of the oxygen that comes off is dissolved by the water and does not rise into the jar.

(2) *Symbols.*—$2(H^2O) = 2H^2 + O^2$.

(3) *Weight-numbers and volumes.*—$36 = 4 + 32$.
4 vols. 2 vols.

That is, 36 parts by weight of water under electroloyis (electrical decomposition) yield 4 parts by weight or 4 parts by volume of hydrogen, and 32 parts by weight or 2 by volume of oxygen.

This is the analytical method of determining the composition of water: ανα (ana) = up; λυω (luō) = I free. Analysis is the breaking up of a compound body into simpler bodies.

EXERCISES ON THE ELECTROLOGIS OF WATER (*Solved*).

N.B.—Weight and volume questions will not be combined.

(34) What weights of hydrogen and of oxygen respectively will be evolved in the electrolitic decomposition of 4 cc. of water?

1 cc. H^2O weighs 1 gram.
4 ,, ,, weigh 4 grams.
36 grams H^2O yield 4 grams H, 32 grams O.
1 gram ,, yields $\frac{4}{36}$,, ,, $\frac{32}{36}$,, ,,
4 grams ,, yield $\frac{4\times4}{36}$,, ,, $\frac{32\times4}{36}$

$\frac{1}{9}$ gram hydrogen, $3\frac{5}{9}$ grams oxygen.

(35) Required 10 cc. hydrogen. What weight of water must be taken?

11·2 litres hydrogen = 11200 cc.
$4\times11\cdot2$,, ,, = 44800 cc.
44800 cc. ,, ,, = yielded by 36 grams H^2O
1 cc. ,, ,, ,, ,, $\frac{36}{44800}$,, ,,
10 cc. ,, ,, ,, ,, $\frac{36\times10}{44800}$,, ,,

$\frac{9}{1120}$ gram.

(35*a*) 1 hectogram, 6 decagrams oxygen are evolved by the electrolitic decomposition of water. Find the volume of hydrogen given off, and the weight of water decomposed.

1 hectogram, 6 decagrams = 160 grams.

32 grams O are given off when $4\times11\cdot2$ litres H are evolved from 36 grams H^2O.

1 gram O is given off when $\frac{4\times11\cdot2}{32}$ litres H are evolved from $\frac{36}{32}$ grams H^2O.

160 grams O are given off when $\frac{4\times11\cdot2\times160}{32}$ litres H are evolved from $\frac{36\times160}{32}$ grams H^2O

224 litres hydrogen, 180 grams water.

(*To be continued.*)

Publications Reviewed.

Natural History Readers for Standards IV. and V. By the Rev. J. G. Wood. London: William Isbister, Limited.

In the case of an author who has devoted his life to the study of his subject, and has written over a dozen successful and valuable books upon it, a reviewer can have but little to say in criticism of a new work, considered either as science or literature. To remark that Mr. Wood understands natural history, and can write about it in a bright, brisk fashion, with his topic well in hand, and all its details duly marshalled, is only to say what 'goes without saying.' Our criticisms upon these Readers must be confined to their suitability as school books for the standards for which they are designed.

From this point of view, both volumes, but especially the one for Standard IV., are open to two observations. The first is that the vocabulary is too easy for the standard; the second that the matter is too full of detail. The first point will be less an objection with teachers than with Her Majesty's inspectors; and our attention was, in fact, drawn to the matter by the knowledge that a London inspector had taken exception to the use of Mr. Wood's earlier standards on this ground. The second is the more important point for the teacher. It makes the book a difficult one indeed, if all the vast variety of detail that is given here is to be even approximately memorised by the children.

This, of course, does not apply if the work is used merely as an extra reader, but only if it be taken as the base of a class-subject examination. In the latter case, however, the work of teaching the innumerable small details of difference between animals that are given here at such full length, and yet in such concise phrase, will be tremendous. In fact, it will be an impracticable task; and as the 'animal life' topic is only one branch of the elementary science subject, the impossibility of really utilising Mr. Wood's book in teaching it is increased.

We will illustrate our meaning by taking one group of animals at random. Here, for instance, is the section of the Standard IV. volume on 'Ruminants.' It occupies (excluding pictures) about thirty-two pages, and in that space we find condensed the anatomy of the stomach of ruminating animals, and brief descriptions of the detailed points of difference between all the following beasts of the group: Buffalo, Cape buffalo, gaur, bison, musk ox, gazelle, ariel gazelle, springbok, gemsbok, chamois, gnu, koodoo, eland, nylghau, deer, elk, reindeer, cariboo, wapiti, carcajou, musk deer, dromedary, Bactrian camel, and llama. We speak with diffidence of the work of a veteran like Mr. Wood, but we cannot but think that the practical teacher will be appalled at the idea of teaching so much detail as a portion only of a class-subject. The names we have cited are simply those of the animals dealt with in forty pages (including illustrations) of a fourth-standard reader of 275 pages; so that, of course, there are about five times as many beasts mentioned in the whole book. We do not think that many teachers will care to undertake to drum even all these unfamiliar names into the heads of Fourth Standard boys; still less will they care to try to add to all the rest of the knowledge which they are expected, in the brief space of some ten months, to pack into the poor little ten and eleven-year-old crania, the particulars of how a springbok differs from a gemsbok, or how they may know a koodoo from a carcajou. We would venture to suggest to Mr. Wood that in his next volume he should not thus enter into the details of species. It seems easy enough to him because he is so thoroughly familiar with his topic; and he naturally desires to make his work complete. But for children, such completeness is not necessary, but is, on the contrary, a stumblingblock in the way of their acquiring broad, general ideas. This, surely, is what it is designed by the framers of the Code that the elementary scholar should acquire—that he should learn the principles of the scheme of animated nature, but not that he should become an adept in universal natural history. What, in our judgment, then, should be done in a natural history reader is to state at length the distinguishing characteristics of a group of animals, and to give full and interesting facts about their habits and modes of life as a whole, but not to dwell on the immense variety of points of difference between the individuals composing the group.

We may now add that the books are so interestingly and easily written that we feel sure that children will readily read them through. Indeed, the volumes might be usefully added to all school libraries, or given as prizes. The illustrations are numerous, and, on the whole, excellent.

The earlier volumes having treated of the animals familiar to English children, Standard IV. goes through the less common mammalia, while Standard V. is devoted to birds, reptiles, and fishes. Invertebrates are left for Standard VI., which is still in preparation.

Animal Physiology. By Vincent T. Murché. London: Blackie and Son.

This is not a perfectly new book, but consists of the three parts, hitherto published separately, of 'Blackie's Physiology,' bound in one volume. We do not know if any slight alterations may have been made; but readers who have seen the three parts of the Physiology in

question may know that they have practically seen this volume.

Its special feature is that the plates have the names of the parts printed upon them, in red ink, instead of these being indicated by the customary method of reference-letters and text beneath the figure. This a good plan in some cases; in the figures of sections of the heart, for instance, it is effective. In other plates, however, the result is bad; the words are so printed as to completely mislead the young student. In the figure showing section of the nose, mouth, and pharynx (fig. 10) the legend 'Salivary glands' is loudly printed in red along the under surface of the tongue (on the genio-hyo-glossus muscle), while as a matter of fact not a gland is to be seen, the whole of these bodies having been dissected away before the drawing was made. The figure has been, of course, copied with very slight alterations from a large anatomical work; but the author of this little book has tried to independently increase the number of the references to the drawing with these fatal results. The anatomical students for whom the picture was originally drawn would, of course, have learned all about the genio-hyo-glossus muscle long before they reached the detailed study of the buccal cavity, and would know that this muscle had nothing to do with salivary glands. It is, perhaps, not wonderful that the head-master of Boundary Lane School should not recognise the muscle in question, but if Messrs. Blackie wanted to originate a new idea in the plates to Mr. Murché's book, they should have called in the supervision of a skilled anatomist, even if it were but a student of a hospital just through his 'first college.' We are not hypercritical in these remarks. The figure with its loud lettering will entirely mislead the pupil. It is in no way advisable to teach profound anatomy in our schools, but what we do teach should certainly be accurate, as far as it goes. Now, we do not know if Mr. Murché mistook the section through an incisor tooth for a salivary gland, but it is most likely that the young readers of his book will do so; and if they do not, they must suppose the muscles of the tongue to be salivary glands. These are the only alternatives that the picture offers a poor child; these are his Scylla and Charybdis on one of which he must make shipwreck.

Nor is this by any means a solitary instance of the mistake that the printing the names on the parts often turns out to be. In anatomical plates, the parts which are referred to are often a great deal smaller than their names. When the long name is printed above the small part, on the picture, instead of a line and a letter of reference to the explanatory text below the cut being used, the consequence is necessarily that the name spreads far beyond the part, and so the picture misleads the bewildered little learner, instead, of aiding his comprehension. Thus, we find the long name 'tendon of Achilles,' which appertains to a tendon only six inches in length, printed (fig. 8) so that it covers the entire muscle of the calf, right up to the knee joint. What conclusion can a child or a novice draw but that the gastrocnemius muscle is in fact the tendon of Achilles? In some of the woodcuts, again, the red printing, is far from legible; we may specially note figs. 6 and 14 in our copy as open to this objection. On the whole, then, we cannot advise other publishers to follow Messrs. Blackie's lead in this new departure; and the more so because we notice that, probably in consequence of the extra expense of the red printing, the number of engravings here is fewer than is usual in similar works; and children learn so readily through the eye that this is a point of some importance.

We have devoted so much attention to the woodcuts because they are the special and new feature of the work, and had they been really as serviceable as they at first sight appeared, would have placed the book in a high position amongst its class. We may speak briefly of Mr. Murché's letterpress.

This is fairly well done, from the literary point of view; the sentences are short, and the words plain and well-chosen. The effort to write lightly and graphically, not infrequently leads to the employment of phrases more picturesque than correct; such, for example, as this—'Some of the nerves pass into the organs of the body. . . . . There they act as masters, foremen, or gangers, and *see* that the work of each organ is properly carried on. *They give their orders and the organs merely do as they are told.*' It may be more amusing to a child to read such a statement than to receive a scientific explanation of how involuntary muscular action is controlled by the nervous system; but the object of teaching physiology is to give the benefits of scientific training to the mind, and not to amuse. The positive errors are not numerous, but still there are several of these. They occur, as might be expected, in the more abstruse sections of the subject. The statement about the accommodation of the eye must suffice for an example. 'The crystalline lens is, as you know, very elastic, and is held in its place by the suspensory ligaments. When we wish to look at an object a long way off, these ligaments are *drawn very tight by some muscles*, to which they are attached. If we next turn our attention to objects close at hand, the ligaments are *allowed to relax*, and the crystalline lens returns to its rounded or convex shape.' This is the exact reverse of the truth. The muscular action is connected with the looking at objects near at hand, the relaxation of the muscular action gives accommodation for far objects. The suspensory ligament of the lens, into which the elastic capsule of the lens passes, is attached to the ciliary muscle, through the intervention of the ciliary processes; the ciliary muscle, by its contraction, pulls forward the ciliary processes, and so takes the capsule of the lens off the stretch, and allows the anterior surface of the lens, by its own elasticity, to become more convex, and thus we view near objects. The cessation of the action of that muscle puts the capsule again on the stretch, and by merely leaving the only muscle concerned in a state of rest, flattens the lens, for viewing far distances. In fact, everybody may be conscious in his own person that 'the eye is rested'—that is to say, the muscle goes off duty—when the gaze is removed from near to far objects.

We need not correct other errors, similarly unimportant, perhaps, in practical bearing, but equally showing that the author has an imperfect acquaintance with his science. The broad facts of such a subject are easily enough read up, as the number of advanced science certificates issued from South Kensington is evidence of. But to write a thoroughly good elementary work, a very real knowledge of a subject is required. The author who knows a great deal more than he puts down is distinguishable in many ways from the one who reads up in order to write upon a subject, but especially in the strict accuracy of even the most sketchy passages that he pens.

On the whole, in the broad outline of the science, Mr. Murché is a trustworthy guide, and his book is sufficiently well-written to give it a fair chance of acceptance amongst elementary science teachers.

Handbook of Agriculture. By R. M. Ewing. With a Preface by Professor Scott. London: W. Swan Sonnenschein and Co.

Professor Scott, who is the editor of *The Farmer's Gazette*, and author of several agricultural books, declares in the Preface with which he has supplied this little volume, that he has never elsewhere met 'in the same small compass, with so compendious a summary of both the principles and practice of agriculture.' The praise is not undeserved or exaggerated. In the course of only some seventy pages of good-sized type, Mr. Ewing really accomplishes the almost incredible feat of giving a very fair outline of his entire subject. We do, indeed, regret that he has not taken more space. So admirably is his work executed, that it were to be wished he had made it somewhat fuller. It is now compressed to the last degree. Every sentence is as full of pith and as bare of words as it is possible to achieve. But this, though useful for that reading for examination which is

scornfully called 'cramming,' does not do an author full credit, or allow of his treating his subject with entire justice. We hope the success of this little work will be sufficient to lead Mr. Ewing to write a longer and more leisurely one at no distant date.

The subjects treated—and really treated, not only mentioned in passing—include soils, cropping, rotation of crops, haymaking, and ensilage; diseases of every kind of crops, insects, weeds, live stock, and the principles of feeding cattle, sheep, horses, pigs, and the description, breeding, and general management of poultry, live stock diseases, and dairy farming.

We confess that when we looked down the table of contents, it appeared simply impossible that so small a book could usefully deal with all the subjects set forth; and, accordingly, we commenced our examination of it with some amount of prejudice against it. But we soon found that Mr. Ewing had most extraordinary abilities for (to use an illustration racy of the soil) compressing intellectual fodder. Small though the bulk is, everything is there; squeezed together, and pressed up, but with the nutritiousness and the palatableness both unaffected. Our readers interested in agriculture as a "South Kensington subject," or in practical farming, should certainly procure this wonderful sixpennyworth.

Botany. By Vincent T. Murché. London: Blackie and Son.

The subject of botany suits Mr. Murché's brisk, terse style. There is a breezy feeling in these pages, which makes them quite bright reading. In fact, the English, though perfectly simple, rises sometimes to a really high level. We take it that Mr. Murché is personally interested in botany, and that this book was a labour of love. A work written in such a spirit is sure to be well done, with accuracy and vigour combined. This is a fair description of Mr. Murché's 'Botany,' which we are able to cordially recommend to teachers of this subject. It is illustrated with over one hundred and forty engravings, all up to Messrs. Blackie's usual high standard in this respect.

How to Manage Schools. A Guide to School Board Members and Managers of Schools. By H. Major, B.A., Inspector to the Leicester School Board. London: Grant and Co.

This book is not designed for teachers, but, nevertheless, they might draw some useful practical hints from its pages. Leicester teachers especially will be glad to know of the existence of the book, which will give them all their local inspector's ideas about school management. The great defect of the book is its tutorial tone. 'Members of School Boards and School Managers' are seldom so humble as it might become them to be, and most of them will feel rather insulted by Mr. Major's patronage. There is an amusing section at the end, where teachers will find the mirror held up to nature. Mr. Major thinks that it will be useful to managers to learn into what classes teachers, in his judgment, may be divided; and he accordingly presents them with a series of sketches, amidst which that of 'the good teacher' finds a place, but does not become very distinguishable, whilst no one can mistake the life-like accuracy of the pictures of 'the untidy,' 'the dogmatic' (the crowning fault of this one being that he 'ignores treatises on school management'), 'the faddy,' 'the whining,' and 'the martinet' teachers. To see ourselves as our inspectors see us is not quite an every-day luxury; but, perhaps, on the whole, we get as much of it as is absolutely necessary for our well-being, without looking for it in print.

Capital for Working Boys. By J. E. McConaughy. London: Hodder and Stoughton.

No teacher could desire a more suitable book as a present for a boy leaving school than 'Capital for Working Boys.' It aims at setting before boys a high ideal, and shows that the best capital they can start with in life, and continue to use through life, consists in the character which they may build up for themselves. There is a crispness in the composition, and an appositeness in the anecdotes and selected instances of successful individuals, chiefly from American sources, which make the book very pleasant reading, and cannot fail to produce a good impression on the youths who peruse it. No school library should be without it.

(*a*) **Oxford and Cambridge Local Examinations in Arithmetic,** from 1858 to 1883.
(*b*) **Answers to Oxford and Cambridge Local Examinations in Arithmetic.** By R. O. T. Thorpe, M.A. London: William Rice, Fleet Street.

The first-named volume is a clear and accurate reprint of all the Arithmetic Questions given to Senior and Junior Candidates since the commencement of these yearly examinations. Actual practice in the work already given is the surest method of testing a candidate's capabilities for passing, and teachers preparing pupils will find the book very useful. It may also be used with advantage by pupil-teachers, and candidates at the Scholarship and Certificate Examinations.

(*b*) The Answers by Mr. Thorpe are carefully printed and we have tested a sufficient number of examples to satisfy us of their accuracy in every respect.

(*a*) **Notes of Grammar Lessons.**
(*b*) **Grammar Exercises.** Parts I., II., III. National Society's Depository, Westminster.

This work contains Notes of Lessons for every part of grammar which enters into the course of study in elementary schools. The method and matter, with the exception of the exercises, are alike admirable, the compiler evidently being a practical teacher of ability. Pupil-teachers, and assistants who have not had the advantage of a pupil-teacher's training, will do well to obtain the book.

We cannot speak so favourably of the Grammar Exercises, which are reprinted from the Notes. They are not carefully graduated, are too long for single lessons, and are entirely wanting in poetical extracts, which present more difficulties than prose, and are now so commonly given. The compiler, we think, has altogether underestimated the time at the disposal of teachers for working the exercises and the quarterly examination papers which are appended.

The Musician: a Guide for Pianoforte Students. By Ridley Prentice. Grade III. London: W. Swan Sonnenschein and Co., Paternoster Row.

We have before had occasion to review most favourably Grades I. and II. of this series, and we observe with pleasure that the book now before us is in every respect fully equal to its predecessors. This grade is specially suitable for pianoforte students who are able to play pieces of moderate difficulty; and a complete list of such pieces, all by classical composers, arranged in progressive order of difficulty, and including those analysed, is given at the beginning of the book.

A brief recapitulation of the substance of the First and Second Grades forms an introduction which enables the pupil, if necessary, to dispense with these grades, and begin at once with the more difficult pieces suited to his capacity.

Every page of this little work is full of interest, and the sympathetic and appreciative sketches of the great masters and their works, which are scattered throughout the volume, cannot fail to instruct and stimulate.

Song-Book for Schools. A Graduated Collection of Songs adapted for the use of Children. By C. Villiers Stanford, Mus. Doc., Organist of Trinity College, Cambridge. London: National Society's Depository.

In this song-book Dr. Stanford has arranged and harmonized a large number of our best old English melodies. It is almost unnecessary to say that the work has been done with much taste, skill, and judgment. A few of the melodies are, we admit, rather difficult, and, to modern ears, somewhat vague in tonality, but their presence is necessary to complete the design, and they do not detract from the value of the collection, which we cordially recommend to all our readers.

A Digest of English History, from 1689 to 1760. By M. Gutteridge, B.A. London: Relfe Brothers.

Mr. Gutteridge claims for this digest of the history of an important epoch in English history that 'it is reliable, tangible, and chronological. In these days of examination the surface to be covered is so wide and the depth to be dug so great, both for pupils and teachers, that he who lightens the labour of the one without injury to the other should be deemed a welcome co-worker.' Mr. Gutteridge has fully maintained his claim. His book is thoroughly practical, its arrangement is clear, and its information precise, suitable, and accurate. When used as a supplement to a full history, it will be very useful for revision and preparation for examination. While well adapted for all junior students, the book is meant more especially for use by University Local Examination candidates.

⁂ *Several Reviews are unadvoidably held over.*

Publications Received.

Blackie and Son—

Animal Physiology. By Vincent T. Murché.
Botany. By Vincent T. Murché.
The Principles of Agriculture.

Chambers (W. and R.)—

Chambers' Graduated Reader. Book V.
Elements of Euclid. By J. C. Mackay, M.A.

Heywood (John)—

English History in Rhyme.
Gardiner's Explanatory Geography. Part I. For standards I. and II.

Longmans and Co.—

The Art of Solving Problems in Higher Arithmetic. By Rev. J. Hunter, M.A.
Longman's Magazine. August.
Longman's Modern Copy Books. By J. Tidmarsh.
Text-Book on Practical Solid or Descriptive Geometry. Part II. By D. A. Low.

National Society's Depository—

Song-Book for Schools. Parts I. to VII., and Complete. By C. Villiers Stanford.
Grammar Exercises. Parts I. to III.

Nelson (T.) and Sons—

The New Royal Reader, No. 6.
The New Royal Reader Home Lesson Books, Nos. 1 to 5.

Simpkin, Marshall and Co.—

Picturesque Wales. By Godfrey Turner.
A Practical Guide to German Conversation. Parts I. and II. By Karl Geugnagel, Ph.D.

Smith, Elder and Co.—

Cornhill Magazine. August.

Willcocks (W. J.) and Co.—

The Magazine of Music. Part V.

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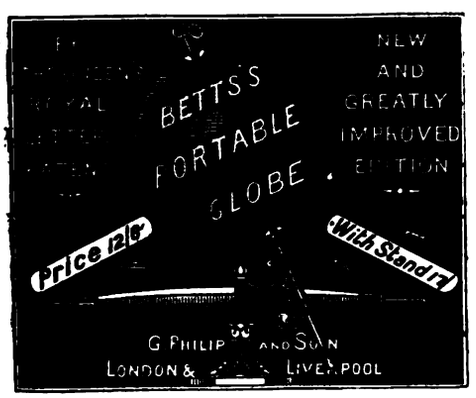

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Hygiene.

BY ALFRED CARPENTER, M.D., M.R.C.P. (LOND.),
Chairman of the Council of the Sanitary Institute.

AIR: ITS HYGIENIC PROPERTIES.

(*Continued.*)

Ozone is oxygen in a condensed state; it is always present in the fresh air, but is absent in the close air of rooms, and not always found out of doors in large towns, and but seldom in great cities. It may be found on one side of a town on one day, and absent in the same place on the next, simply because the wind has changed to the opposite quarter. We do not know how it is formed in nature. It may be evolved by electric action, or oxygen, set free by various agencies may take the form of ozone when first eliminated. It has a peculiar smell. It is able to set iodine free from potassium iodide, by which its presence may be recognised with certain limitations. The smell which is observed when an electric machine is worked is that of ozone. It is half as heavy again as oxygen; that is, 2 vols. of ozone form 3 vols. of oxygen. It is an important agent in all sanitary operations; probably produced by motion, and set free by growing plants, and by other chemical actions, it assists to diminish the incidence of disease-producing agencies. It seizes upon the so-called albumenoid ammonia compounds, oxidizes them, and renders them comparatively harmless. It is found near to the surface of the sea, probably in some way connected with the physical changes which are always going on at the surface of the water, when that water is in constant movement. Its presence in the air on one side of a great city and its absence in the other, arises from its being used up in oxidizing the organic matters which have been discharged into the air by the decomposition of dead matter in the city. Thus ozone is never found where such decomposition is going on, when that is in excess of the quantity of ozone produced. Its production is associated with many of the processes which are in vogue for the purification of the atmosphere. It may be simply oxygen in an electrified form, intimately associated with the molecular state of the gas, but chemists are not thoroughly agreed as to its nature. Those who wish for more information upon this agent and its associations should study Dr. Cornelius Fox's important work on Ozone and Antozone, which gives a complete account of the 'when, where, why, and how is Ozone observed in the atmosphere.'

Chemical Examination of the Air.—The presence of O is easily shown by the eudiometer, as is explained in every work upon elementary chemistry. N is found when P has been burnt in a receiver containing a measured quantity of air, and so placed over water that the fumes of the P_2O_5 which result from the union of the O with the P will be absorbed by the liquid. One-fifth of the original volume disappears, and N remains with the minute quantity of CO_2 which is always present in the air. The presence of CO_2 is shown by passing a measured volume of air through a solution of lime or baryta water. The volume of air being known, and the quantity of carbonate of lime or baryta which has formed in the solution being ascertained, the percentage of CO_2 in the air experimented on will be easily worked out, but the process is very delicate and requires close attention to minute detail. The *watery vapour* varies with the temperature; a purely dry air is seldom met with; a cubic foot of air may have from one grain up to 10 grains of water diffused through it. The watery vapour may be collected by passing a given quantity of air through calcium chloride. The increase of weight of the latter after the operation will give the amount of watery vapour.

NH_3 is collected by drawing the air by means of an aspirator through wash-bottles containing a measured quantity of water which is perfectly free from NH_3 and by then determining the free and albumenoid NH_3 by Wanklyn's method. This process should be studied by all who are engaged in sanitary work. It is set out in full in 'Water Analysis,' by J. A. Wanklyn, to which I must refer the reader, as space prevents me giving all the details.

Ozone is indicated by test papers which have been dipped in solution of KI and starch. The paper should be exposed for a definite time, if possible, with exclusion of light. The quantity of ozone is said to be made out by observing the depth of blue colour produced and comparing it with a scale which has been previously assessed at its value. The conclusion may be erroneous, as nitrous acid (N_2O_3) will affect the test paper when present to the extent of $\frac{1}{100000}$ of the volume of the air, and a minute portion of the

iodine set free never acts upon the starch, as it is immediately volatilized or oxidized. These agencies can, however, be averaged and allowed for.

Microscopical Examination of Air.—There are a great number of materials found suspended in the air, organic as well as inorganic. The observations which have been recently made out connected with the magnificent sunsets of 1883 will be a case in point, for it seems to be established beyond refutation that the minute dust from volcanic action reaching the upper regions of the air, continue to circulate round the earth for long periods before the whole is again deposited upon its surface. These particles allow of refraction, and so produce the colours which have been so manifest at eventide. The matters suspended in the air may be collected by arranging a small funnel with a microscopical slide below its point, which has been moistened with glycerine. The end of the funnel must be with the slip of glass enclosed in an air-tight chamber, such as is provided by Pouchet's aeroscope; from this a small glass tube passes out and is connected with an aspirator; as the water runs away, the air impinges on the slide, any solid particles which it may contain are arrested by the glycerine, or the air may be drawn through pure distilled water and the resulting deposit examined after it has settled. The collected inorganic particles are found to be particles of *silica*, *calcium salts*, and *iron oxides*. If the water is slowly evaporated, *chlorides* are found, especially if the specimen has been collected near the sea. A large number of living cells and the debris of dead creatures are sometimes arrested. Ehrenberg collected more than 200 forms of *rhizopods*, *tardigrades*, and *anguillulæ*, *micrococci*, *bacteria*, *spores of fungi*, varying with the season of the year; *pollen* from flowers, *starch grains*, *dried cells* of all kinds, such as those of *pus* and *mucus*, *epidermic* scales both animal and vegetable. It has been shown how very minute particles are made visible by a ray of light passing through a dark room, as any one may see for himself. The suspended matters which are found in enclosed spaces are indicative of the actions which are taking place in those spaces. The dust from the ward of a hospital contains just those particles which we might expect to find there—germs which will propagate disease if carried to a favourable site. It is probable that cattle diseases, such as pleuro-pneumonia and foot-and-mouth disease, are spread in this way, whilst small pox, scarlatina, and measles, may owe their diffusion to a similar source; and erysipelas may be spread from case to case by currents of air, carrying with them the spores which are able to create the disease.

Some of these spores may be dried and retained as dust for long periods; when moistened with water they revive and are able to propagate their species or set up the disease anew. The air of mines, workshops, and factories are seen to contain particles sufficiently numerous to set up diseases in the lungs, etc., of the workpeople employed, whilst in some occupations, such as woolsorters, disease so often arises that it becomes recognised by the name of the occupation of the persons attacked. Bacilli of various kinds are cultivated in the raw material which is being worked into a manufactured article, and the hands employed may suffer seriously from the effects of the cacozyme.

Sewer air may propagate disease by carrying the germs and discharging them by ventilators into the open street, to the possible injury of the passengers. When sewers smell, there is a fault somewhere, which should be rectified by a removal of its cause, not, as is too often the case, simply by closing the opening from which the smell comes. The air of vaults may be shown to contain injurious particles, and organic matter has been arrested in air from marshes which is supposed to be the cause of intermittent fever. It is certain that microscopical examination of air will, in the future, be a necessary part of the work of a disease preventer.

THE REMOVAL OF WASTE AND IMPURITIES.

The waste which arises from the mere act of living, the impurities which necessarily follow from that act, and which must be incessantly removed, are some of the most difficult problems of sanitary work in great towns. The impurities consist of defilements of the air which have to be reduced to the lowest amount by natural ventilation if possible, and if natural ventilation is not equal to the work, then by artificial means. They also consist of the natural refuse from sinks, baths, and closets, and are intimately associated with the formation of drains and sewers, as well as of traps and means for ventilating the same. The removal of such impurity invites a question as to the transit of sewage by the dry method or by water carriage. It entails a consideration also of sewer gas and septic organisms generally, as well as the use of antiseptics, deodorisers, and disinfectants. We will consider each of these under its separate heading.

Ventilation.—The means whereby air is set in motion may be considered under two heads. 1. Natural. 2. Artificial.

Natural Ventilation.—This is promoted by changes in temperature and moisture; by the winds; and by the law which causes the diffusion of gases through space. The changes in temperature and moisture are such as arise from the unequal weight of the air when heated by the sun's rays or chilled by cold blasts from distant regions. Tables are given in scientific works by which calculations are made as to velocities produced by difference of temperature, and rules are laid down for making the calculations. In ordinary cases the difference in pressure cannot be obtained by direct observation, but must be gathered by finding out the difference of temperature of the outer and inner air of the room under consideration. A formula is given by Prof. de Chaumont, which is as follows: 'The height from the aperture at which air enters to that from which it escapes multiplied by the difference of temperature between the outside and inside and divided by 491.' This will give the actual movement produced by unequal weight of air. The 491 indicates the fraction which is called the co-efficient of the expansion of gases. If Fahrenheit is the thermometer employed, it should be remembered that the volume of a gas expands $\frac{1}{491}$ times for every degree of risen temperature, or $\frac{1}{275}$ if the Centigrade is used.

Another rule may also be remembered with advantage, viz., that air rushes into a vacuum with a velocity which a heavy body would acquire in falling from a height of five miles, viz., 1,304 feet per second. The velocity in feet per second of falling bodies is equal to nearly eight times the square root of the height through which they have fallen, and fluids pass through an orifice in a partition with a velocity which is equal to that which a body attains in falling through a height

equal to the difference in depth of the air on the two sides of the partition. This is called the Rule of Montgolfier. The causes of movement are constantly acting with every change of temperature, and it is added to by the alteration in moisture which such changes bring about. There are losses of power produced by friction and angles, but these are not great except in cases when the openings are too minute to be of much service. The most powerful ventilating agent is the wind; its agency must be considered in all plans for ventilating a given place. The pressure of the wind equals three-quarters of an ounce on each square foot when the air moves at the rate of three miles per hour; 2 ozs. at five miles; 4 ozs. at seven miles; 8 ozs. at 10 miles; and 1 lb. when the air travels at the rate of fourteen miles per hour. This power of the wind is but too often forgotten in artificial systems of ventilation. It can be always more or less trusted to, if there is room for open windows and simple ventilating apertures. These openings allow the changes of temperature and moisture (which must arise when a number of people occupy a room) to come into play. The great difficulty is to arrange the openings so that a draught may not impinge upon some of the occupants, the result of which is but too generally an outcry on their part for the opening to be closed. Windows should always be placed at opposite sides of the room. They should reach to the ceiling, and open both top and bottom. The top sash may be made to open inwards, so that the draught may be towards the ceiling in the first instance; a wire gauze may cover the space which is left at the lower part when the sash is raised, provided care be taken that the gauze be kept clean. Various kinds of ventilators are provided, such as glass louvres, movable sheets of glass with perforated mouldings. Tobin's tubes, by which air is brought from pure sources and delivered in the room at suitable places, pierced conical bricks, etc., etc. It is necessary to consider—1st. The inlets for fresh air. 2nd. The exits for used-up air; and 3rd. the number of people who are likely to occupy the room or building.

(To be continued.)

—o—

The New Class-Subject, 'Elementary Science.'

(What to teach, and how to teach it.)

BY RICHARD BALCHIN.

The work for Standard V., as set forth in the code, is as follows:—(*a*) Animal or plant life; (*b*) the chemical and physical principles involved in one of the chief industries of England, among which agriculture may be reckoned; (*c*) the physical and mechanical principles involved in the construction of the commoner instruments, and of the simpler forms of industrial machinery.

This syllabus is extremely vague—probably intentionally so—in order to allow the teacher a wide freedom of choice. As a matter of fact, however, we require no further explanation of the general intention of the Department beyond that given in the instructions—'to prepare a progressive course of lessons adapted to cultivate habits of exact observation, statement, and reasoning.'

It will, of course, be necessary for the teacher to arrange a syllabus of about sixty lessons and submit it to H.M. Inspector. A reading book on 'Elementary Science' is required for Standard V.; and the scheme of lessons will necessarily be based upon the contents of that book. I will assume that No. 3 of 'Hughes' Science Readers' is used. From page 1 to page 60 treats of the following subjects:—The three states of matter; the physical properties peculiar to each state; simple machines; heat. Here is ample material for a year's work. A course of sixty lessons may easily be arranged from this bare outline. As a fact, this part of the reader exactly embraces the work for the first stage 'Mechanics' as given in the 'Fourth Schedule' of the code; and if I were taking 'Mechanics' as a specific subject, I should certainly use this book as the 'General Reader' for Standard V. A complete syllabus of lessons on this division of the book appears in volume I. page 223 of this magazine; hence, I need not repeat here what I then gave with considerable detail.

From page 86 to page 174 of the class-book we have material for another and distinct course of lessons. The subject is 'Elementary Chemistry.' Hence the teacher who uses this book has a choice of two subjects to serve as the basis of his lessons on Elementary Science for Standard V. He may confine his attention to the first part of the book and take 'Natural Philosophy,' or he may devote the time to 'Elementary Chemistry.' I will assume the latter course is adopted. The following is therefore a syllabus of lessons in 'Elementary Science' as a class-subject for Standard V., based upon the contents of the latter part of 'Hughes' Science Reader,' No. 3.

Lessons I. to IV.

Elements and compounds; composition of chalk and red oxide of mercury.

Lessons V. and VI.

Difference between a chemical compound and a mechanical mixture. Composition of water and of air.

Lessons VII. to X.

Analysis and synthesis. Analysis of red oxide of mercury; of chalk; and of water. The combination of oxygen and iron; of carbon dioxide and lime; and of the fumes of hydrochloric acid and ammonia.

Lessons X. and XI.

The chemistry of air. Experiment with the bell-jar and phosphorus.

Lessons XII. and XIII.

Oxygen: its preparation and properties.

Lessons XIV. and XV.

Hydrogen: its preparation and properties.

Lessons XVI. and XVII.

The chemistry of water. Analysis by (*a*) heat; (*b*) electricity; (*c*) sodium.

Lessons XIX. to XXII.

Chief compounds of oxygen. (*a*) Oxide of iron; (*b*) oxide of mercury; (*c*) carbon dioxide; (*d*) nitrous oxide, etc.

LESSON XXIII.

Carbon: its various forms and chief properties.

LESSONS XXIV. and XXV.

Chief compounds of carbon. (*a*) Carbon dioxide; (*b*) hydro-carbons.

LESSON XXVI.

Nitrogen: its preparation and properties.

LESSONS XXVII. to XXX.

Ammonia: its source, properties, and compounds.

LESSONS XXXI. and XXXII.

Chlorine: its preparation and properties.

LESSONS XXXIII. to XXXVI.

Compounds of chlorine. (*a*) Chloride of lime; (*b*) chloride of ammonia; (*c*) chloride of sodium.

LESSONS XXXVII. to XL.

Phosphorus: its mode of preparation, uses, and compounds.

LESSONS XLI. to XLIV.

Sulphur: its mode of preparation and chief compounds.

LESSONS XLV. to L.

Economic chemistry, *e.g.*, chemistry of food. Fats, sugar, starch, cellulose, milk, cheese, etc.

LESSONS LI. to LX.

Agricultural chemistry. Composition of wheat and other kinds of corn; of roots, etc.; composition of soils.

It will at once be seen that the above syllabus, besides being adapted for the class-subject 'Elementary Science' for Standard V., is also arranged to suit the requirements of the first stage of the specific subject—'Chemistry.' In the Fourth Schedule of the code we find the following outline given as indicating the work of the first stage of this specific subject:—'Elementary and compound matter. Illustrations of combination and decomposition in such bodies as hydrochloric acid, water, oxide of mercury, and rust of iron.' The 'Science Reader' (Hughes') so exactly embraces this official syllabus that, as I intend taking 'Chemistry' as a specific subject next year, I shall certainly use this book as the 'general' reader for Standard V.

Perhaps it may be well I should here mention that my arrangement of 'Elementary Science' as a class-subject in Standards I. to IV. inclusive is intended to lead up to the specific subjects in Standards V. to VII.; and that 'Chemistry' and 'Mechanics' are the two specifics I have chosen. *This* year, however, being with me a ten-months' year, and my school quite a new school, I am not taking any specific subjects at all. And I should strongly advise all teachers opening new schools to follow my plan in this respect; for if, while the school is only partly full, and there are comparatively few boys in the upper standards, these subjects are begun, the work is thrown into considerable confusion in future years. I would, of course, from the very day of the opening of the school, start an interesting and attractive series of object lessons, not for examination purposes, but merely to make the school a popular one in the neighbourhood.

There is one point in connection with this subject of chemistry that I ought to explain. The nomenclature of the science, as well as the manner of stating the chemical formulæ, are at present in an unsettled state. This is, of course, inevitable in the case of such a progressive science as chemistry, where fresh discoveries are continually being made, involving the modification of old statements and the adoption of an altered formula. The symbols, however, remain the same. For instance, the symbols H, O, N and Ca stand respectively for hydrogen, oxygen, nitrogen, and calcium. Shall I, for 'water' and 'ammonia,' write H_2O and H_3N, placing the electro-positive element first (as being the one which appears at the negative pole during electrical analysis), or shall I use as formulæ for these binary compounds OH_2 and NH_3, as I find Dr. Frankland does in his 'Lecture Notes for Chemical Students'? And with respect to the nomenclature. Shall I, in the case of the compounds CO, CO_2, and H_2CO_3, use the terms carbonic oxide, carbonic anhydride, and carbonic acid? or shall I call the first oxide of carbon, and the second carbon dioxide and carbonic acid indifferently? Shall I call chalk calcic carbonate, or carbonate of lime? For the compound expressed by the formula K_2SO_4 which term shall I use? Sulphate of potash, or sulphate of potassium, or dipotassic sulphate, or potassium sulphate?

It is quite evident that before I begin to teach even little boys the most elementary chemistry, I must settle what nomenclature to use, and what system of formulation to adopt. My difficulty is just this. I must assume that *some* at least of my boys will pursue the subject further when they leave school. Well, what will they then think of me and my teaching if they find to their cost that most of what I have told them they have to *unlearn* before going any further? They will perhaps conclude that I had far better have taught them nothing. And yet I cannot possibly be continually referring to the same substance under three or four different names, nor every time I use a formula show that there are very good reasons why it should be written in two or three other ways.

I have decided in these notes to use the ordinary names and the most commonly received formulæ, except in cases where such are positively erroneous. For instance, I shall use the term 'oxide of iron' in preference to 'ferric oxide,' and adopt the formula H_2O (water) rather than OH_2. I shall, however, call CO_2 carbon dioxide, and not carbonic acid, for the simple reason that it is not an acid at all with the H_2O abstracted, there being in CO_2 no hydrogen for a metal to displace; it is, in fact, an anhydride.

I feel there is no injustice done to the boys by the adoption of these terms, because my lessons will deal only with the most common every-day substances, to which common every-day names will always be given. If I were teaching a class of adults, the case would be quite different. *Then* most assuredly I should follow Dr. Frankland's system, and as certainly, Dr. Aveling's method of teaching.

(To be continued.)

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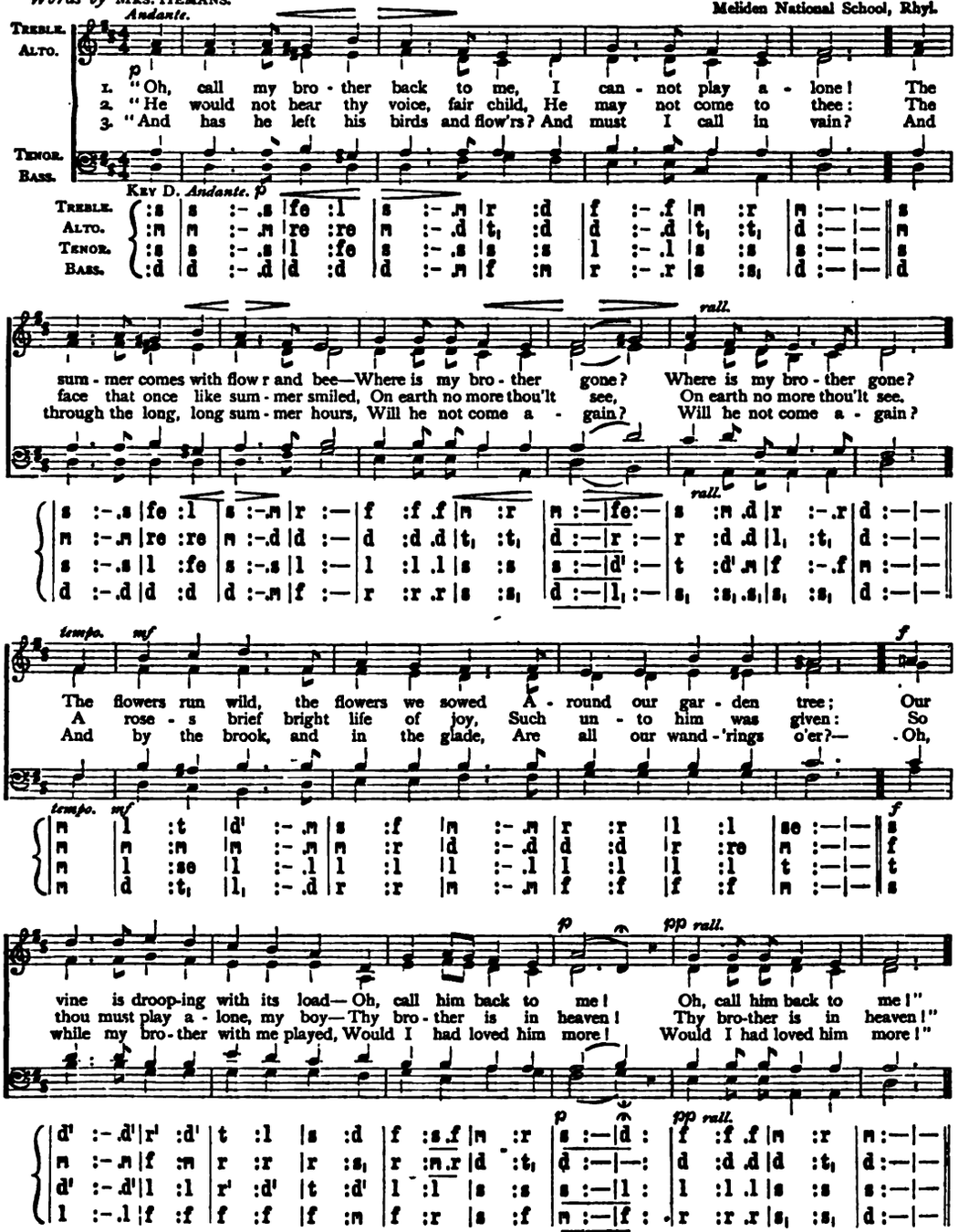
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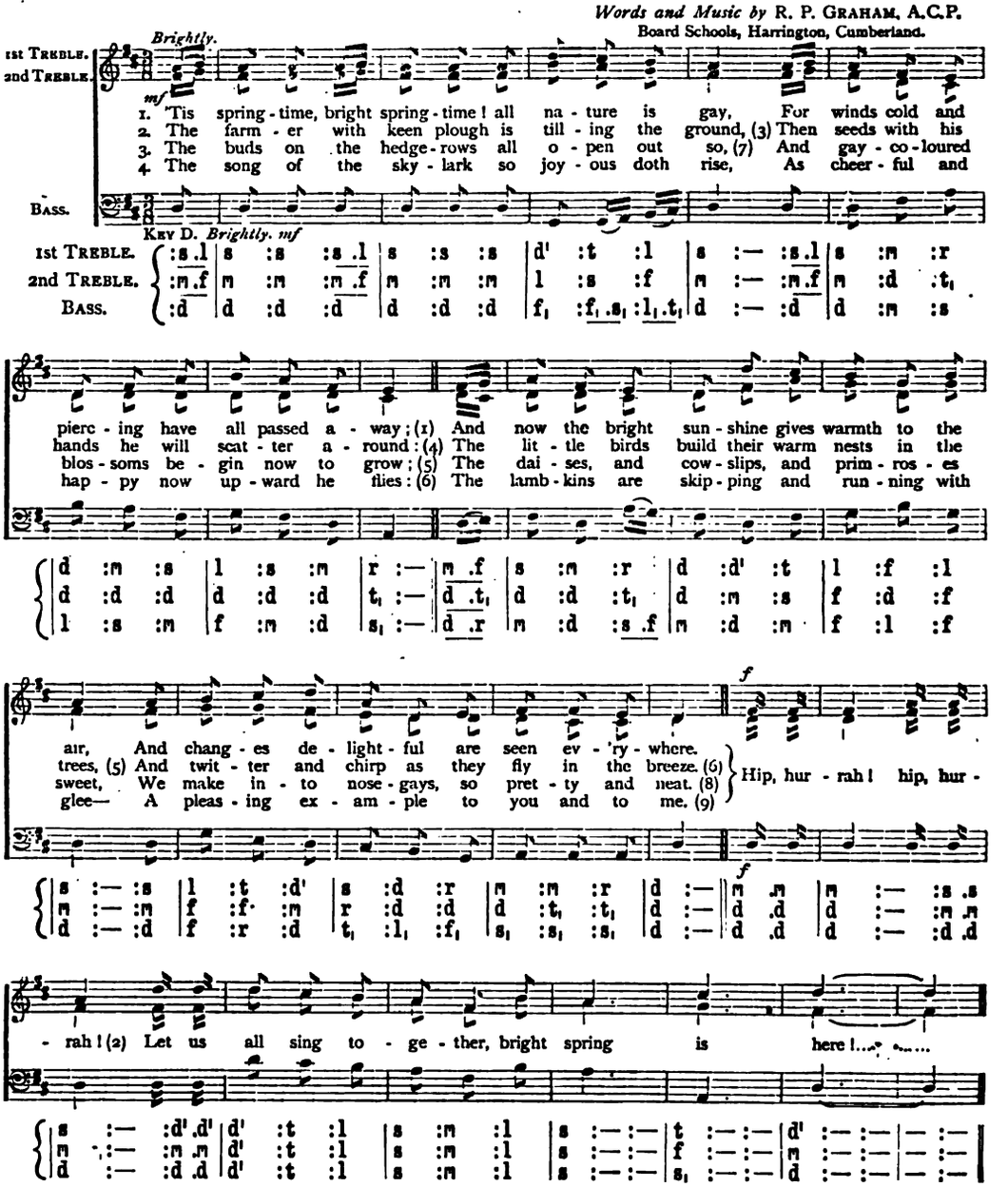
TREBLE.
ALTO.
TENOR.
BASS.
1. "Oh, call my bro - ther back to me, I can - not play a - lone! The
2. "He would not hear thy voice, fair child, He may not come to thee: The
3. "And has he left his birds and flow'rs? And must I call in vain? And
KEY D. Andante. p
sum - mer comes with flow r and bee—Where is my bro - ther gone? Where is my bro - ther gone?
face that once like sum - mer smiled, On earth no more thou'lt see, On earth no more thou'lt see.
through the long, long sum - mer hours, Will he not come a - gain? Will he not come a - gain?
rall.
tempo.
mf
The flowers run wild, the flowers we sowed A - round our gar - den tree; Our
A rose - s brief bright life of joy, Such un - to him was given: So
And by the brook, and in the glade, Are all our wand - 'rings o'er?— Oh,
f
p
pp rall.
vine is droop-ing with its load—Oh, call him back to me! Oh, call him back to me!"
thou must play a - lone, my boy—Thy bro - ther is in heaven! Thy bro-ther is in heaven!"
while my bro - ther with me played, Would I had loved him more! Would I had loved him more!"

"Practical Teacher" Money Prize Competition—First Prize (Action Songs

'TIS SPRING-TIME.

Words and Music by R. P. GRAHAM, A.C.P.
Board Schools, Harrington, Cumberland.


Brightly.
1st TREBLE.
2nd TREBLE.
mf
1. 'Tis spring-time, bright spring-time! all na-ture is gay, For winds cold and
2. The farm-er with keen plough is till-ing the ground, (3) Then seeds with his
3. The buds on the hedge-rows all o-pen out so, (7) And gay-co-loured
4. The song of the sky-lark so joy-ous doth rise, As cheer-ful and
BASS.
KEY D. Brightly. mf
1st TREBLE. :s .l | s :s :s .l | s :s :s | d' :t :l | s :— :s .l | s :m :r
2nd TREBLE. :m .f | m :m :m .f | m :m :m | l :s :f | m :— :m .f | m :d :t1
BASS. :d | d :d :d | d :d :d | f1 :f1 .s1 :l1 .t1 | d :— :d | d :m :s
pierc-ing have all passed a-way; (1) And now the bright sun-shine gives warmth to the
hands he will scat-ter a-round: (4) The lit-tle birds build their warm nests in the
blos-soms be-gin now to grow; (5) The dai-ses, and cow-slips, and prim-ros-es
hap-py now up-ward he flies: (6) The lamb-kins are skip-ping and run-ning with
d :m :s | l :s :m | r :— | m .f :s :m :r | d :d' :t | l :f :l
d :d :d | d :d :d | t1 :— | d .t1 :d :s :t1 | d :m :s | f :d :f
l :s :m | f :m :d | s1 :— | d .r :m :d :s .f | m :d :m | f :l :f
f
air, And chang-es de-light-ful are seen ev-'ry-where.
trees, (5) And twit-ter and chirp as they fly in the breeze. (6)
sweet, We make in-to nose-gays, so pret-ty and neat. (8)
glee— A pleas-ing ex-am-ple to you and to me. (9)
Hip, hur-rah! hip, hur-
s :— :s | l :t :d' | s :d :r | m :m :r | d :— | m .m | m :— :s .s
m :— :m | f :f :m | r :d :d | d :t1 :t1 | d :— | d .d | d :— :m .m
d :— :d | f :r :d | t1 :l1 :f1 | s1 :s1 :s1 | d :— | d .d | d :— :d .d
-rah! (2) Let us all sing to-ge-ther, bright spring is here!
s :— :d' .d' | d' :t :l | s :m :l | s :— :— | t :— :— | d' :— :— | — :—
m :— :m .m | d' :t :l | s :m :l | s :— :— | f :— :— | m :— :— | — :—
d :— :d .d | d' :t :l | s :m :l | s :— :— | s1 :— :— | d :— :— | — :—

(1) Rub hands briskly together, then gradually extend them right and left respectively. (2) Wave right hand twice. (3) Extend arms to the front, fists closed. (4) Imitate sowing of seed. (5) Point to the right or left. (6) Hands raised to level of head, fingers in rapid motion. (7) Hands partly extended to front, palms facing upwards, tips of fingers and thumb together at first, then expanded. (8) Imitate the act of smelling flowers. (9) Point with extended finger.

Article 106 (*b*).

Merit Grant in Infant Schools.

BY MRS. MORTIMER,

Lecturer on Kinder-garten at the Home and Colonial Training College, London.

Section II.—Phenomena of Nature.

LESSON—THE MOON AND STARS.

LAST week we had a long talk about the sun. Do you remember anything you told me about it? It gives us light and heat, it makes the plants and flowers grow. Yes, that is right. When do we see the sun? In the daytime. Do you ever see it at night? No. Well, I went out last night, and saw something very bright in the sky. What was that? It was the moon. How many of you saw the moon last night? Not many of you; how was that? Yes, you were in bed. Do you know if the moon shines every night? No, sometimes there is no moon to be seen. So, you see, sometimes the moon shines very brightly, and at other times you cannot see it. Now, perhaps, some of you who have seen the moon can tell me something about its shape. It is round like the sun. Is it always round? No, sometimes it has a little piece off one side. Sometimes there is only half a moon. Sometimes only a quarter, and sometimes only a very little strip. So, you see, the moon does not always seem the same shape to us. When the moon is only a little strip we say it is the new moon. If you watch the new moon, you will see that after a few nights it is much larger. The moon goes on getting larger until it gets quite round. Can you tell me what we say of it then? We say it is the full moon. If you had noticed the first day of the new moon, and kept count of the days, you would find that fourteen days had passed while the moon was becoming full. Do you know what happens when the moon is full? It begins to get smaller. Yes, first it gets to half a moon, and then smaller and smaller. How long do you think the moon is in getting quite small again? Fourteen days. Yes, just the same time as it took to become quite round. Who can tell me how many weeks there are in fourteen days? Two weeks. Then, you see, the moon is two weeks getting large, and two weeks getting small. How many weeks is that? Four weeks. What do four weeks make? A month. Yes, we say there is a new moon every month. When the moon is getting smaller we say it is 'on the wane.' What does the moon give us? Light. Yes, we like to walk out when the moon is shining brightly. The light makes everything look so pretty. Can you look at the moon? Yes, it does not hurt our eyes like the sun. Why not? Because it is not so strong. The light that comes from the sun is of a golden colour, but the light of the moon is white like silver, so that we always talk about the silvery moon and the golden sun.

Very often at night the moon does not shine, and then it would be very dark indeed if something else did not try to give us light. What do you think I mean? The stars. What can you tell me about them? There are a great many stars all over the sky. What can you say about their size? They are very small, some much smaller than others. What else can you tell me? They are very bright and seem to be moving or dancing about. What do we call this kind of moving? You do not know. There is a pretty little song you sing about the stars that tells you what they do. Now sing me part of that song? 'Twinkle, twinkle, little star.' Well, then, what can you say about the movement of the stars. They twinkle. Do you like to see the stars? Yes, they look very bright and pretty in the sky. Of what colour are they? They are silvery like the moon. Do you see the stars only when there is no moon shining? Oh no, sometimes we see both the moon and stars. Do you think you could reach the stars? No, they are a long way off. If you were to build a house on the top of another very high indeed, you would still not be able to touch the sky. It is very far away.

Section II.—Scenes of Common Life.

LESSON—MODES OF CONVEYANCE.

I. *The different modes of conveyance to be named.*—Now, children, let us suppose we have a half-holiday. Where would you like to go? To Richmond—Regent's Park—Zoological Gardens. Yes, we could go to any of these places and have a very happy time, but we will imagine we are going to the Zoological Gardens this afternoon. I wonder who can tell me how we can get there. Where are we now? At school. Yes, but where is your school? Near King's Cross. Very well; now we want to know how to get from King's Cross to the Zoological Gardens. Do you know where the Gardens are? In Regent's Park. Who has ever been to the Park? How did you get there? We walked. Yes, you can walk, but it is rather a long way, and it is very much better to ride, then you can play about when you get there without getting tired. Who has ever ridden to Regent's Park? In what did you ride? In an *omnibus*. And you, Tommy? In a *train*. Well, here is one little boy says he went in his father's *cab;* that must have been nice, I am sure. Now is there anything else in which you could ride besides an omnibus, train, or cab? Very well, Mary says her father took them all in his *cart* when they went. When I went to the Zoological Gardens last I saw a great many carriages outside the gates. What were they doing there? Quite right, they were waiting to take away the ladies and gentlemen whom they had brought there. Is there no other means by which we can get from one place to another? Well, if you stand by King's Cross station, you will often see people riding in something else that you have not mentioned. Yes, it is a *tram-car*. What are tram-cars like? Yes, they are something like omnibuses, and James says they are something like trains. In what are they like omnibuses? They are drawn along the streets by horses, and they stop when any one wants to get in. Why did James say they were like trains? Because they run on lines like the trains.

Now, I am quite sure you have all seen gentlemen riding on something that you have not yet mentioned. Well, Mary? I have seen a gentleman on a *tricycle*. And there is something very much like a tricycle; what is that? A *bicycle*. What is the difference between a tricycle and a bicycle? One has three wheels, and the other has two. Yes; it is very easy to remember, because this part of the word means 'wheel' (underlining 'cycle') and 'bi' means 'two'; and 'tri' means 'three,' so that 'bi-cycle' means 'two wheels,' and 'tri-cycle' means 'three wheels.' Haven't you had a word with 'tri' in it before? Yes, 'tri-angle.' What does that mean? The other day I saw a gentleman riding by himself, but it was not on a bicycle or a tricycle. Can you tell me what he was on? He was on a *horse*. We say, he was riding horseback.

Now you shall name for me, and I will write them on the slate, the different means by which we can get from one place to another.

We can walk, we can ride in a train, omnibus, tram-car, cab, carriage, cart, on horseback, tricycle, or bicycle.

II. *Advantages of each.*—Which of all these ways of travelling do you like best? One little girl says she likes going in the train best. Why, Bessie? Because the train goes so quickly. Yes, it does; and if we are in a hurry, we like to go in a train. But does the train go to every place that we want to go to? No, the trains only go to stations, and then we have to walk from the station. If we want to ride all the way, what must we go in? An omnibus. Well, Tommy, what are you going to say? The other day I went to my aunt's in an omnibus, and it did not take me all the way. I had to get out and walk. How was that? Because the omnibus never goes down my aunt's street; it always goes along the end of it. Does the omnibus always go the same way? Yes; all omnibuses go the same way every day; so, unless you are going the way the omnibus goes, you will have to walk

some part of the way. What must we ride in if we want it to go exactly the way we wish? In a cab. Do you often ride in a cab? Why not? Because it costs too much money. Yes; if you go ever such a little way in a cab, you must pay the cabman one shilling; but you can go a very long way in an omnibus for twopence or threepence. Do you know why you can ride so much cheaper in an omnibus? Yes, that is right; a great many people ride in the omnibus, and every person has to pay the man, so that altogether he gets a great deal; but only one person rides in a cab, and he has to pay all the money himself, even if two or three friends are with him. Now, there is something else in which we can ride a very long way for twopence; what is that? Which do you like riding in best? Why do you like the tram best? It goes much more easily. Can the tram go any way we like? Why not? Yes, you remember you told me before, it has lines to run on, just like the train has. It is the lines that make the cars go so easily. Do you know what makes the omnibus shake so much? Yes, it is very often the rough, stony roads that it has to run along. Which is the larger, the tram or omnibus? The tram is much larger. Does it have more horses to draw it? How is it that the two horses are able to draw the large tram along? The lines make it easy for the horses to draw it; they could not draw the car if it were not for the lines. Why?

III. Recapitulation.—Now we have found out that we like riding in cabs, but we cannot do so because they are too dear. Who can ride in cabs? Rich people. In what do very rich people ride? In carriages.

We like riding in tram-cars better than in omnibuses; but sometimes the tram does not go the way we want to go, and then we use the omnibus.

Sometimes we like to go in the train, especially if we are in a hurry, because it goes quickly, and, like the tram and omnibus, it does not cost much money.

Sometimes we are obliged to have a cab, though it is dear. Do you know when that is? Yes, when you are going into the country, you have to take luggage with you, and you have to ride in a cab to the station. Why could you not go in the omnibus? Because we cannot take much luggage in an omnibus. Where does the cabman put the luggage? On the top of his cab. Yes, he can carry a great deal of luggage there.

Section IV.—Common Employments.

LESSON—THE CARPENTER.

Apparatus.—Good picture of carpenter at work, and specimens of the tools used by him. (A child's tool box would supply the necessary specimens.) Six pieces of wood properly prepared to form a box, also a rough piece of wood.

I dare say you remember that we had a long talk about the bricklayer a short time ago, and to-day I want you to tell me about another man who helps the builder build the house.

We said that while the bricklayers are building the walls, some other men come and put in large pieces of wood on which the floors are to be made. What did we call these men? Carpenters. What else do they do? They nail down the floors, and put in the doors, and windows, and the stairs. Of what are all these things made? They are all made of wood. Then what part of the house does the carpenter do? He does all the woodwork. Does he wait until the bricklayers have finished? No; he is obliged to do some of his work at the same time. The teacher should then let the children repeat the parts of the house made by the carpenters while the bricklayers are at work. Now I want you to tell me the names of the tools used by the carpenter, and for what he uses them. The teacher then, pointing to the pieces of wood, would say, What have I here? Some pieces of wood. Yes, and with these we will try to make a box. How many pieces of wood are there? Six pieces. Do you think the carpenter would get his wood like this already to make the box. What would he have to do? He would have a large plank. What would he do to it? He would have to cut it into the right pieces. How would he get the right length, etc., of the pieces? He would measure it. With what does he measure? The teacher should here show the children a rule, and tell them that the carpenter's rule is generally two feet in length, and hence he calls it a *two-foot rule*. The children's attention should also be directed to the way the two-foot rule folds, and the advantage of this pointed out. Now, Harry, come and show how the carpenter measures the wood. Yes; but what must he do before he takes the rule away? He marks the place. With what? A piece of *lead pencil*. See, here is a piece. Is it like those you use? No, it is much thicker. Then what does he do? He cuts it. With what does he cut the wood? With a *saw*. Come and find me the saw. Do you think you could saw the piece of wood? Well, John thinks he can, but I am afraid he will not be able to, for it is rather difficult to use the saw. Which part must he hold? The handle. Do you know what we call this part of the saw (pointing to the teeth)? Of what is it made? It is made of steel. Now, you see John cannot manage the saw very well—that is why I had the wood cut for you. I had to get the carpenter to do it.

Now let us see if we can find out where the different parts go? Quite right, this large piece is the bottom of the box. Yes, there is another piece like it. Where do you think that will go? Very well, then you have the top and bottom of the box. Now, what other parts have you? Two long pieces. Where will they go? They will do for the sides. And where will these short pieces go? They will do for the ends. We have found out the parts of the box. How shall we put them together? Willy says we might *nail* them together. Another boy says we can *screw* them, and Mary says we can *glue* them. They are quite right, we could nail them, or screw them, or glue them, but we are going to join them another way. Look at the edges of these pieces of wood, and tell me what you see. There are little pieces sticking out. And what do you notice on the other pieces? Little pieces cut out. Yes; these edges have been cut like this. Now look, and I will put these edges together. What do you notice? They fit into each other. Then, you see, this is another way of joining wood. We call this *dovetailing*. The teacher might then show the children how the edge of the blackboard is fastened on to the board, *i.e.*, by a *groove* and a *tongue*. A small piece of match-boarding would be a familiar and easy example of this kind of join. The *tenon and mortise* join would be best illustrated by the frame of the cupboard door or the schoolroom door. The names tenon and mortise, of course, would not be mentioned.

Now how do you think the carpenter cuts the wood out for these kinds of joins? Yes, he sometimes uses a small thin saw, and sometimes a chisel. Can you show me the *chisel*? You must be very careful when you touch the chisel, for it is very sharp, and likely to hurt you. Who has seen the carpenter using his chisel? With what does he strike it? With a large wooden hammer. Yes: we call this the *mallet*. Now look at this piece of wood, and tell me the difference between it and the pieces used for the box? It is very rough, and the others are smooth. Could the carpenter make it smooth? How? By planing it. What does he use to do this? A *plane*. Show me the plane. Yes, it is a large piece of wood with a piece of sharp steel in it. See, I have taken it out. What is it like? A wide chisel without a handle. Yes, that is right; and I have seen a chisel used like a plane. Now if we wanted to nail our box together, what should I have used to knock in the nails? A *hammer*. Show me the hammer? Of what is it made? A piece of iron with a wooden handle. How shall we fasten the lid on the box! Do you want it fixed down firmly? No, we want it to open and shut. Well then? We must have some hinges. See, here are the hinges; how shall we put them on to the box? We must screw them on? How? With the *screw-driver*. What must you first do? Make some holes with the *gimlet*.

Did you use the gimlet for the nails? No; but the screws will not go in unless holes are first made. Why would it not do to nail the hinges on? They would not be strong enough. That is right, the nails would get loose, and then the hinges come off So, you see, the screws hold things more firmly than the nails do. Sometimes when the carpenter is using nails they do not go in the right way, and he is obliged to pull them out again What does he use for this? The *pincers*. Show me the pincers. What were you going to say, Charlie? He uses the other part of the hammer. Yes; some hammers are made like this one, and we are able to use it to pull out nails. Do you know what we call the table at which the carpenter works? His *bench*. How many of you have seen a carpenter's bench. The children's attention should be directed to picture of the bench, or a little model might easily be obtained for them to see. Now the carpenter does not want to hold his wood still with his hands. Why not? Because he wants his hands to work with. So he puts the wood between these two pieces, and then with these long wooden screws he fastens it very tightly. You told me that the carpenter sometimes fastens the wood together with glue. In what does he have his glue? In the *glue-pot*. See, here is one. There are really two pots, one fitting into the other. In which does the carpenter put the glue? In the inner one. And what does he put in the outer one? Water. Why? To make the glue soft when he puts it on the fire. Yes; the glue would not get soft if he put the inner pot on the fire, it would only burn.

As a recapitulatory exercise the children should write on their slates the names of the tools used by the carpenter, and then name the use of each to the teacher.

The different kinds of joins should be asked for, and the children should also name the different things made by the carpenter.

(To be continued.)

—o—

Physiology.

BY ARTHUR NEWSHOLME, M.D. LOND.,

Gold Medallist and University Scholar, Physician to the City Dispensary.

Chapter X.—THE BLOOD—(*continued*).

Cause of Coagulation of Blood.—Many theories have been propounded to explain the clotting of blood after it has been shed, and the immunity from clotting while it remains in the living vessels. It is now certain that the true explanation is the formation of fibrin, from the union of certain substances which did not previously exist as fibrin.

What prevents a similar formation of fibrin in the living organism is uncertain. The existence of warmth, or constant movement, or absence of exposure to air does not explain the immunity from coagulation, as in converse conditions, coagulation may be prevented. Doubtless there is an equilibrium established between the blood-vessels and the blood contained in them, which in some way inhibits the formation of fibrin. This is shown (1) by the facts that, after death, blood remains fluid for a considerable time in the veins, but will coagulate immediately on removal from them; and that blood coagulates earliest in the larger vessels. (2) The same conclusion is confirmed by the fact that a wire introduced into a living blood-vessel becomes coated with fibrin, and forms a centre for extensive clotting. By this method, large swellings of arteries (aneurisms) have occasionally been cured. (3) When the internal coat of a blood-vessel is injured by tying or otherwise, coagulation occurs.

The following experiments reveal the real character of blood coagulation:—

(1) Take a quantity of horse's blood and surround the vessel containing it with a freezing mixture of ice and salt. Clotting is indefinitely postponed, and all the corpuscles settle to the bottom. Remove the liquid plasma from the mixture and it commences to coagulate. It follows that blood-corpuscles are not an essential part of the clot.

(2) Take a portion of fresh blood and whip it sharply with a bundle of small twigs. Fibrin is deposited on the twigs, and the blood remaining in the vessel, although apparently the same, will not clot, however long it is left. The fibrin thus obtained is in minute threads, possessing the general properties of proteids. It is insoluble in water and in dilute saline solutions. Dilute hydrochloric acid causes it to swell up, but not dissolve.

(3) If some of the liquid plasma obtained in the first experiment have sodium chloride or some other neutral salt added to saturation, a white, flaky precipitate appears. If this is removed, the remaining liquid is no longer coagulable. To this precipitate the name of *plasmine* has been given. It can easily be dissolved by a little water, and for a short time remains liquid, soon, however, becoming gelatinous, and finally forming a clot. Inasmuch as plasmine is soluble in water, it cannot be identical with fibrin, and yet it speedily produces fibrin when in solution. Is it, then, a mixture of more than one substance, which tend to combine and form fibrin? That this is the explanation may be confirmed by the following experiments:—

(4) If the fluid from a hydrocele (which is a dropsical accumulation in a serous cavity) be mixed with some serum or whipped blood, coagulation occurs, though neither alone will clot.

(5) If serum be treated to saturation with solid sodium chloride, a precipitate is produced, like plasmine in being readily soluble in water, but unlike it in not coagulating on standing. This material when added to hydrocele fluid causes it to coagulate, and is evidently the material which effected this in the last experiment (4). The same substance may be prepared by diluting blood with from ten to twenty times its bulk of water, and passing a brisk stream of carbonic acid through it. It is named *fibrinoplastin* or *paraglobulin*.

(6) If hydrocele fluid be treated in the same way with carbonic acid or sodium chloride to saturation, a somewhat similar precipitate is obtained, known as *fibrinogen*. When this precipitate has been dissolved in a dilute saline solution, and added to serum, coagulation occurs, while the hydrocele fluid *minus* fibrinogen no longer causes the coagulation of serum.

(7) If precipitated fibrinogen be mixed with precipitated fibrinoplastin, and the two dissolved in dilute saline solution, the fluid mixture will soon coagulate with the production of normal fibrin.

It is evident then that plasmine is a mixture of fibrinoplastin and fibrinogen, and that when these are made to combine fibrin is produced.

There is some evidence of the existence of a third body, favouring coagulation, which only affects the rapidity of coagulation, but not the amount of fibrin produced. This is *fibrin-ferment*, and it is probably owing to the scarcity of this, that when the fibrinogen and fibrinoplastin prepared by the carbonic acid method are mixed, clotting is very difficult or entirely

absent. The action of *neutral salts* is somewhat doubtful, but their presence seems to be essential for the occurrence of coagulation.

The condition in which fibrinogen and fibrinoplastin exist in blood is still very doubtful. Some of the fibrin-factors, probably, originate in the white corpuscles; as under the microscope, coagulation is seen to be preceded by the breaking up of white corpuscles. It has been suggested that fibrinogen is constantly present in the blood, and that fibrinoplastin and fibrin-ferment are produced by the disintegration of the white corpuscles. But even if this is correct, part of the subject still remains unsolved; for many corpuscles must die and break up in the blood, and yet no coagulation occurs. The supposition of an inhibitory power of the blood-vessels still remains necessary.

CHAPTER XI.

CIRCULATION OF THE BLOOD.

General view of Circulation.—It will be convenient first to give a general description of the blood circulation, entering into the details of its mechanism after describing the anatomy of the circulatory organs.

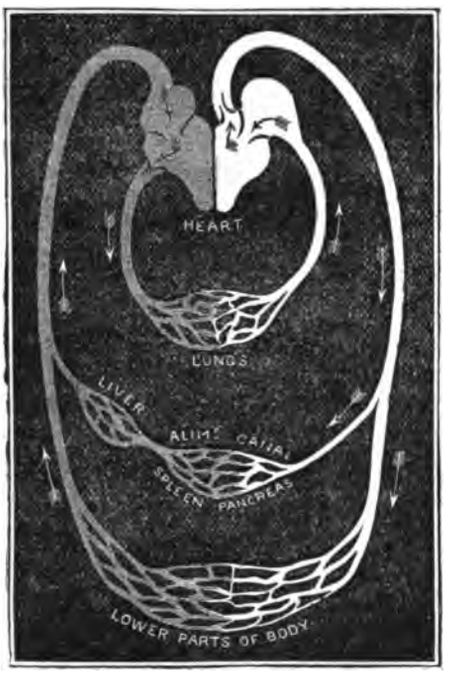


Fig. 42.—Theoretical diagram of the Circulation. The darker-shaded part shows the venous blood.

The heart contains four cavities, the two on one side not communicating directly with those on the other. Supposing a drop of blood to be in the superior or inferior vena cava. It passes thence into the right auricle (Fig. 42), and is carried through the orifice between the auricle and ventricle into the right ventricle. The valves placed between these prevent any reflux of blood, and on contraction of the heart, it is forced into the pulmonary artery. By this it is carried to the lungs, being distributed to the pulmonary capillaries and returning greatly purified along the pulmonary veins, which empty it into the left auricle. The contraction of the auricle drives it into the left ventricle, and on contraction of the latter it is sent into the aorta. Its subsequent course varies with circumstances. It may be carried to the head, or limbs, or trunk, being distributed by capillaries, which return the blood by the superior and inferior vena cava to the right auricle. A certain portion of it, however, takes a more complicated course. After being distributed to the alimentary canal and spleen, the veins from these parts do not empty directly into the inferior vena cava, but join to form the portal vein, which breaks up into capillaries in the liver, then forms the hepatic vein, which empties into the inferior vena cava.

It will be seen that there are two circuits or circulations performed by the blood, a lesser or *pulmonary circulation*, and a greater or *systemic circulation*. That part of the systemic circulation which passes through the liver is known as the *portal circulation*.

Fig. 43.—Theoretical section of Heart, showing the four cavities and origin of large vessels.
(*a*) Aorta; (*bb*) Pulmonary arteries, arising from a common trunk; (*c*) Superior vena cava; (*dd*) Right and left pulmonary veins; (*f*) Right auricle; (*g*) Left auricle; (*h*) Inferior vena cava; (*i*) Right ventricle; (*k*) Left ventricle; (*l*) Inter-ventricular septum.

(*To be continued.*)

ANSWERS TO
Pupil Teachers' Examination Papers.
AUGUST 30TH, 1884.
FIRST YEAR.
Pupil Teachers at end of First Year.

Three hours and a half allowed.

Arithmetic.

MALES.

1. Find the least number that is divisible by 5, 6, 7, 8, 9, and 10, and leaves in each case the remainder 4.

No. = L.C.M. of 5, 6, 7, 8, 9, 10, + 4.

2)5, 6, 7, 8, 9, 10

5, 7, 4, 9, 5

$(2\times7\times4\times9\times5)+4=\underline{2524}$. Ans.

2. What fraction is $3\frac{3}{5}$ of $1\frac{3}{11}\frac{3}{3} - \frac{8}{33}$, of $4\frac{1}{8} + 2\frac{1}{16}$ of $7\frac{1}{2}$?

$$\frac{3\frac{3}{5}\text{ of }1\frac{3}{11}\frac{3}{3} - \frac{8}{33}}{4\frac{1}{8} + 2\frac{1}{16}\text{ of }7\frac{1}{2}} = \frac{\frac{18}{5}\times\frac{36}{33} - \frac{8}{33}}{\frac{33}{8} + \frac{33}{16}\times\frac{15}{2}}$$

$$= \frac{\frac{216}{55} - \frac{8}{33}}{\frac{132}{16} + \frac{495}{32}} = \frac{\frac{324 - 40}{165}}{\frac{50 + 189}{12}}$$

$$= \frac{284}{165}\times\frac{12}{239} = \underline{\frac{944}{1105}}. \text{ Ans.}$$

3. Express ·4875 of a guinea as the decimal of 12s. 6d.; and find in yards the value of ·327 of a mile.

$$\frac{\cdot4875\text{ of }21\text{s.}}{12\text{s. }6\text{d.}} = \frac{10\cdot2375}{12\cdot5} = \underline{\cdot819}. \text{ Ans.}$$

·327 of 1760 yds.

$$= \frac{327 - 3}{990}\times1760$$

$$= \frac{324}{990}\times1760$$

$$= \underline{576\text{ yds.}} \text{ Ans.}$$

4. *A* can do a piece of work in 10 days, and *B* can do it in 8 days. After *A* has worked 3 days, in how many days will *A* and *B* together finish the remainder?

A can do $\frac{1}{10}$ in a day; *B* can do $\frac{1}{8}$;

A and *B* $\frac{1}{10} + \frac{1}{8} = \frac{4+5}{40} = \frac{9}{40}$.

Amount done by *A* alone $= \frac{3}{10}$,

,, left to be done by *A* and *B* $= \frac{7}{10}$.

day. days.

$\therefore \frac{9}{40} : \frac{7}{10} :: 1 : x$

$= \frac{4}{9} \times \frac{7}{10}$

$= 3\frac{1}{2}$ days. Ans.

FEMALES.

1. How much money will be required to pay the following bill:—

19 lbs. of beef at 11d. per lb.
$13\frac{1}{2}$,, mutton at 9d. per lb.
$9\frac{1}{2}$,, mutton at $9\frac{1}{2}$d. per lb.
$6\frac{3}{4}$,, lamb at 11d. per lb.
$17\frac{1}{2}$,, beef at 10d. per lb.
$3\frac{1}{2}$,, suet at $8\frac{1}{2}$d. per lb.

		£	s.	d.
19 lbs. of beef at 11d. per lb.	=	0	17	5
$13\frac{1}{2}$,, mutton at 9d. per lb.	=	0	9	$11\frac{1}{2}$
$9\frac{1}{2}$,, mutton at $9\frac{1}{2}$d. per lb.... ...	=	0	7	$6\frac{1}{2}$
$6\frac{3}{4}$,, lamb at 11d. per lb.	=	0	6	$2\frac{1}{4}$
$17\frac{1}{2}$,, beef at 10d. per lb.	=	0	14	$4\frac{1}{2}$
$3\frac{1}{2}$,, suet at $8\frac{1}{2}$d. per lb.	=	0	2	$5\frac{3}{4}$
Amount required	=	£2	17	11

2. Find the Greatest Common Measure of 169037 and 66429; and the Least Common Multiple of 44, 48, 52, and 96. What do you mean by *Measure* and a *Multiple*?

66429)169037(2
132858
36179)66429(1
etc., etc.

G.C.M. = 121. Ans.

4)44, 48, 52, 96
11. 13, 24

L.C.M. = 4 × 11 × 13 × 24 = 13,768. Ans.

A *Measure* is any number which will divide another without a remainder; thus 6 is a measure of 24.

A *Multiple* is a number which contains another an equal number of times, thus 24 is a multiple of 6.

3. Add together $\frac{7}{10}$ $5\frac{3}{8}$, $\frac{5}{24}$, and $3\frac{19}{24}$.

$\frac{7}{10} + 5\frac{3}{8} + \frac{5}{24} + 3\frac{19}{24}$

$= 8\frac{21+32+5+38}{48}$

$= 8\frac{96}{48}$

$= 10$. Ans.

4. Find the cost of 25 acres 1 rood 10 poles at £42 2s. 4d. per acre.

	£	s.	d.	
1 r. = ¼ of 1 a.	42	2	4	= Cost of 1 acre.
		25		
	1052	18	4	= ,, 25 acres.
10 p. = ¼ of 1 r.	10	10	7	= ,, 1 rood.
	2	12	$7\frac{3}{4}$	= ,, 10 poles.
	£1066	1	$6\frac{3}{4}$	= cost of 25 a. 1 r. 10 p.

Grammar.

MALES AND FEMALES.

1. *Toll* for the *Brave!*
Brave Kempenfelt is *gone*,
His *last sea-fight* is *fought*;
His work of glory *done*.

Analyse these lines and parse the words in italics.

Sentence.	Kind of Sent.	Subject.	Predicate.	Object.	Extension.
(a) Toll for the Brave	P. S.	[you]	toll	for the Brave (ind.)	
(b) Brave Kempenfelt is gone	P. S.	Brave Kempenfelt	is gone		
(c) His last sea-fight is fought	P. S.	His last sea-fight	is fought		
(d) His work of glory done	P. S.	His work of glory	[is] done		

Toll—Reg. int. verb, act., imp., pres., 2nd, plur., agreeing with its nom. *you* und.
Brave—an adj. of quality, used as a com. noun, masc., plur., obj., gov. by *for*.
brave—adj. of quality, qualifying *Kempenfelt*.
is—aux. verb to *gone*, used instead of *has*, to indicate perfect tense.
gone—past part. of the verb *to go*, referring to *he*.
is gone—irreg. intr. verb, act., ind., perf., 3rd, sing, agreeing with its nom. *he*.
last—adj. of number, ordinal, qual. *sea-fight*.
sea-fight—comp. com. noun, neut., sing., nom. to *is fought*.
fought—past part. of *to fight*, referring to *sea-fight*, forming with *is* the pres. ind., 3rd, sing., pass. of *to fight*.
his—pers. pro., masc., sing., 3rd, poss., gov. by *work*.
done—past part. of *to do*, referring to *work*, forming with *is* the pres. ind., 3rd, sing., pass. of *to do*.

2. Explain the use of the adjective 'brave' in the first line and give similar instances.

'Brave' in the first line of the verse is an adjective, used as a noun. It stands instead of a noun which would include all those who perished in the foundering of the ship, of which Kempenfelt was the commander.

Other examples. We honour the Good. He loves the Beautiful. Punishment awaits the Wicked.

3. Write out the past indefinite tense of each of the verbs, 'toll,' 'go,' 'do,' 'fight.'

Toll (Past Indefinite).

1. I tolled	1. We tolled
2. Thou tolledst	2. You tolled
3. He tolled	3. They tolled

Go (Past Indefinite).

1. I went	1. We went
2. Thou wentest	2. You went
3. He went	3. They went

Do (Past Indefinite).

1. I did	1. We did
2. Thou didst	2. You did
3. He did	3. They did

Fight (Past Indefinite).

1. I fought	1. We fought
2. Thou foughtest	2. You fought
3. He fought	3. They fought

Geography.

(*Answer two Questions.*)

1. Draw a map of the West Coast of Ireland, with the names of the capes and inlets.

2. Give an account of the mountain system of Scotland.

Scotland is a mountainous country, especially in the N. and W. The principal ranges of mountains lie parallel with each other, and stretch across the country from NE. to SW.

The three chief ranges are (1) The Lowthers and Cheviots, (2) The Grampians, (3) The Northern Highlands.

(1) The Cheviots form part of the boundary between England

and Scotland, and the Lowthers separate Dumfries from Peebles and Lanark.

(2) The Grampians stretch across Perth and Inverness. They contain Ben Nevis, the highest Scottish mountain (4368 feet), and many peaks almost as high, as Ben More, Ben Ledi, Ben Lawers, Ben Macdhui, Ben Cruachan, Schiehallion, and Lochnagar.

(3) The Northern Highlands lie north and west of the Caledonian Canal. They form a great plateau. The chief heights are Ben Wyvis, Ben Attow, and Ben More.

3. Name the principal lakes in British North America, and the rivers with which they are connected.

The principal lakes in British N. America are Superior, Huron, Erie, and Ontario, in the basin of the River St. Lawrence; Athabasca, Great Slave, and Great Bear Lakes, in the basin of the Mackenzie River; and Lake of the Woods, L. Winnipeg, L. Winnipegos, Deer Lake, and L. Wollaston, connected by the River Nelson with Hudson Bay.

History.

1. How often did Julius Cæsar visit Britain? Give some account of the Roman invasion under him.

Twice: first in 55 B.C.; second in 54 B.C. Julius Cæsar was Governor of Gaul, and finding that the Gauls had received help from Britain, he invaded the island to punish the inhabitants in 55 B.C. He came with two legions, and landed at Walmer or Deal, after a sharp fight with the natives. After being in the island a fortnight, his fleet was partially destroyed by a storm, and he thought it prudent to return to Gaul. He invaded Britain the following year with five legions (30,000), and 2,000 horse. The Britons were led by Cassivelaunus. Cæsar followed them on their retreat across the Thames to the West of London, and attacked the fortified camp of their leader. As the Kentish people were unable to render Cassivelaunus any help, he was compelled to make terms with Cæsar, who took hostages, settled the amount of tribute, and returned to Gaul.

2. Mention some of the principal events connected with the Saxon conquest of this country.

On the decline of the Roman power in Britain, the Picts and Scots invaded England, and the Teutonic tribes from the Elbe and district ravaged the coasts. Both these enemies were driven back by the Roman general, Theodosius, in 367. When the Romans left Britain (410), these enemies returned, the Britons unsuccessfully coped with the Picts and Scots, and, it is said, their chief, Vortigern, got the aid of Hengest and Horsa, who turned against him, and took the land for themselves and their friends. For nearly 100 years tribes of Jutes, Angles, and Saxons arrived, the Britons were driven further and further westward, till they occupied only Wales and Cornwall. King Arthur is spoken of as their chief opponent. He is stated to have been slain in 542. The Saxons established eight separate and independent kingdoms, the chiefs of which were continually at war. Ultimately these were united under Egbert. The introduction of Roman Christianity took place in 596.

3. Write a list of the names and dates of our Danish kings, and describe the dominions of the most famous of them.

	A.D.	A.D.
Sweyn ...	1013—	1014.
Canute ...	1017—	1035.
Harold ...	1035—	1040.
Hardicanute	1040—	1042.

The most famous of these Danish kings was Canute. He ruled over Norway, Sweden, Denmark, and England, besides some say) receiving the homage of the King of Scotland.

Composition.

Write from memory the substance of the passage read to you by the Inspector. The passage was as follows:—

Pope Pius the Second had a little white puppy of eleven months old, of which he was very fond, and which he called Musetta. One day as the Pope was sitting in the Vatican garden, transacting business, Musetta clambered up the side of a water cistern and tumbled in. The Pope's ear caught the piteous tone of her bark, and he sent his attendants to look after her. They rescued her, and brought her back to him. Next day, in the same garden, a big monkey broke loose and worried Musetta nearly to death. The Pope prophesied that his favourite was not destined to enjoy a long life; and, in fact, ten days afterwards the luckless Musetta, sitting in an open window at a great height above the ground, was blown out by a sudden gust of wind and killed. The Pope moralised to his attendants: 'Let men learn from the fortunes of beasts. We may escape twice, but the third peril is fatal. Amend your lives before the third call comes.'

Needlework.

FEMALES.

One hour will be allowed for this exercise in the afternoon.

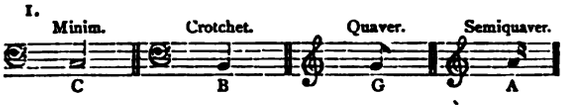
Music.

A quarter of an hour allowed for this paper.

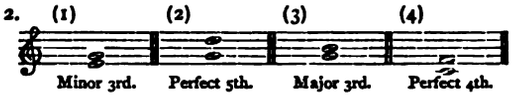
(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

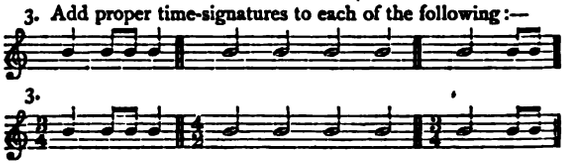
1. Write above each of the following notes its value-name (semibreve, &c.), and below each its pitch-name (C, D, E, &c.):—

1.



2. Write below each of the following intervals its name (major third, &c.):—

2.

3. Add proper time-signatures to each of the following:—



TONIC SOL-FA NOTATION.

1. Write a nine-pulse tone, using three-pulse measures.

1. |d :—:—|—:—:—|—:—:—‖

2. Write the names of the following intervals:—(1) *me* to *soh*; (2) *soh* to *ray*^{1}; (3) *soh* to *te*; (4) *doh* to *fah*.

2. (1) Minor 3rd; (2) Major or Perfect 5th; (3) Major 3rd; (4) Perfect 4th.

3. Write the following an octave higher:—

	m	d	m	s	l	s	m
3.	m^{1}	d^{1}	m^{1}	s^{1}	l^{1}	s^{1}	m^{1}

SECOND YEAR.

Pupil Teachers at end of Second Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

1. Define *superficies, right angle, term or boundary, scalene triangle, rhombus, parallel straight lines*, and write out the axiom which may be regarded as the definition of geometrical equality.

A *superficies* is that which has only length and breadth. When a straight line standing on another makes the adjacent angles equal to one another, each of the angles is called a *right angle*.

A *term or boundary* is the extremity of anything.
A *scalene triangle* is that which has three unequal sides.
A *rhombus* is a four-sided figure, which has all its sides equal, but its angles are not right angles.
Parallel straight lines are such as are in the same plane, and which, being produced ever so far both ways, do not meet.
Axiom 8.—Magnitudes which coincide with one another, that is, which fill exactly the same space, are equal to one another.

2. Upon the same base, and on the same side of it, there cannot be two triangles that have their sides which are terminated in one extremity of the base, equal to one another, and likewise those which are terminated in the other extremity.

Euclid, Book I., Prop. 7.

3. If from the ends of a side of a triangle, there be drawn two straight lines to a point within the triangle; these shall be less than the other two sides of the triangle, but shall contain a greater angle.

Euclid, Book I., Prop. 21.

Arithmetic.

FEMALES.

1. Simplify:—(*a*) $\frac{1}{1+\frac{1}{1+\frac{1}{2}}}$; (*b*) $\frac{3}{7}+\frac{2}{5}$ of $\frac{3}{10}-\frac{3}{17}$.

(*a*)
$$\frac{1}{1+\frac{1}{1+\frac{1}{2}}}$$
$$=\frac{1}{1+\frac{1}{1\frac{1}{2}}}$$
$$=\frac{1}{1+\frac{2}{3}}$$
$$=\frac{1}{\frac{5}{3}}$$
$$=\frac{3}{5}. \text{ Ans.}$$

(*b*)
$$\frac{3}{7}+\frac{2}{5} \text{ of } \frac{3}{10}-\frac{3}{17}$$
$$=\frac{3}{7}+\frac{1}{5}-\frac{3}{17}$$
$$=\frac{18+7-4}{42}$$
$$=\frac{21}{42}$$
$$=\frac{1}{2}. \text{ Ans.}$$

2. Reduce $\frac{3}{17}$ of $6\frac{2}{3}$ of £3 5s. 0d. to the fraction of £4 17s. 6d.

$$\frac{\frac{3}{17} \text{ of } 6\frac{2}{3} \text{ of } £3\ 5s.}{£4\ 17s.\ 6d.}$$
$$=\frac{\frac{3}{17}\times\frac{20}{3}\times\frac{12}{1}}{\frac{19}{1}}$$
$$=\frac{3}{17}\times\frac{20}{3}\times\frac{12}{1}\times\frac{1}{19}$$
$$=\frac{240}{323}. \text{ Ans.}$$

3. What do you mean by a *Prime* number? Write down the prime numbers between 90 and 100, and resolve 24 and 42 into prime numbers.

A *Prime number* is one which can be equally divided only by itself and unity.

97 is the only prime number between 90 and 100.
$24=2\times2\times2\times3$
$42=3\times2\times7$. Ans.

4. Convert $\frac{1}{64}$ and $3\frac{11}{125}$ as decimals.

$$\frac{1}{64}=.015625. \text{ Ans.}$$
$$3\frac{11}{125}=3\frac{176}{1000}=\frac{.176}{25}=\frac{.704}{100}=.00704. \text{ Ans.}$$

Grammar.

MALES AND FEMALES.

1. Analyse the following from the words 'then burst his mighty heart,' and parse the words in italics:—

For when the noble Cæsar saw him *stab*,
Ingratitude, more strong than *traitors'* arms,
Quite vanquished him: then *burst* his mighty *heart*,
And in his mantle muffling *up* his face,
Even at the base of Pompey's statua,
Which all the while ran blood, great Cæsar *fell*.
—'JULIUS CÆSAR.'

ANALYSIS.

Sentence.	Kind of Sent.	Connective.	Subject.	Pred.	Object.	Extension.
(*a*) Then burst his mighty heart,	Princ. Sent.		His mighty heart	burst		then (*time*)
(*b*) And in his mantle muffling up his face, even at the base of Pompey's statua, great Cæsar fell.	P.S. coord. with (*a*)	And	great Cæsar muffling up his face in his mantle	fell		even at the base of Pompey's statua (*place*)
(*c*) Which all the while ran blood.	Adj. to *statua* in (*b*)	*In rel.*	which	ran	[with] blood (ind.)	all the while (*time*)

PARSING.

Stab—Irreg. trans. verb, act., inf., pres., gov. by *saw*.
ingratitude—abs. noun, neut., sing., nom. to *vanquished*.
traitors'—com. noun, masc., plur., poss., gov. by *arms*.
quite—adv. of manner, qual. *vanquished*.
vanquished—reg. trans. verb., act., ind., past, 3rd, sing., agreeing with its nom. *ingratitude*.
burst—irreg. intrans. verb, act. or middle voice, ind., past, 3rd, sing., agreeing with *heart*.
heart—com. noun, neut., sing., nom. to *burst*.
up—adv. of manner, qual. *muffling*.
which—rel. pro., neut., sing., 3rd, agreeing with its antecedent *base*, and nom. to *ran*.
all—adj. of quantity, qual. *while*.
the—adj. of distinction, limiting *while*.
while—= time, adv. used as a noun, neut., sing., obj., gov. by *during* understood.
ran—irreg. intrans. verb, act., ind., past, 3rd, sing., agreeing with its nom. *which*.
blood—com. noun, neut., sing., obj., gov. by *with* understood.
fell—irreg. intrans. verb, act., ind., past, 3rd, sing., agreeing with its nom. *Cæsar*.

2. Point out and explain the force of the adjective suffixes in the following:—

At which time would I, being but a moonish youth, grieve, be effeminate, changeable, proud, fantastical, apish, shallow, inconstant, full of tears, full of smiles.—SHAKESPEARE.

ish in *moonish*, a little like, rather so.
ate in *effeminate*, having the quality of.
able in *changeable*, that may or can be.
ical in *fantastical*, having the quality of.
ish in *apish*, like, rather like, having the nature or quality of.
ow in *shallow*, like: lit. meaning, like a shelf.
ant in *inconstant*, the participle ending of the word, denoting quality.

3. Paraphrase the following:—

Music the fiercest grief can charm,
And fate's severest rage disarm;
Music can soften pain to ease,
And make despair and madness please;
Our joys below it can improve,
And ante-date the bliss above.

" The power of music over the human heart is almost unbounded. Under its influence the deepest sorrow is assuaged, the deepest feeling of misfortune is forgotten, and anguish and madness lose their terrors; it helps to increase and render more deep our earthly joys, and thus enables us to anticipate the happiness awaiting us after death.

Geography.

(*Answer two Questions.*)

1. Draw a map of Switzerland, marking the lakes and rivers.

2. Describe the mountains of British India.

The chief range of mountains in India is the Himalaya range,

which stretches across the whole of the north of the peninsula, and is the highest in the world.

The table-land of Thibet is very high, and the slope of the Himalayas is longest on its north side. On the south it descends abruptly to the plain of Hindostan.

The Solyman range of mountains separating India from Afghanistan and Beloochistan also has its abrupt slope towards India, the plain of the Indus lying at the foot.

Crossing the plain of the Ganges the country again rises into the Vindhya range, and further south the Sautpoora mountains forming the base of the triangular part of India. The centre is occupied by a large table-land, the other two sides being bounded by the East and West Ghauts. The Ghauts terminate in one range, lofty and rugged, called the Neilgherries. The Eastern Ghauts are lower, and more broken than the Western, through which there is not a single opening to the coast for hundreds of miles.

3. What are the climate and productions of the Colony of Victoria?

The climate of Victoria is temperate, resembling in many respects that of Great Britain, except that it is drier and warmer. The average rainfall is similar to that of England, but it occurs during the rainy season, and as it falls on a soil which does not readily absorb it, there are frequent floods in the rivers, and drought and scarcity at other periods.

The climate is mild enough for grapes, oranges, and other semi-tropical fruits to be grown in the open air.

The chief productions of Victoria are gold, copper, iron, coal, wool, hides, wheat, wine, and timber.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. If a draper by selling cloth at 3s. 4d. a yard gains 8 per cent., what per cent. will he gain by selling it at 3s. 6d. a yard?

Selling price of 100 to gain 8 per cent. = 108.

s. d. s. d.

$\therefore$ 3 4 : 3 6 :: 108 : S.P.

$$= \frac{108 \times 42}{40}$$

$$= 113\tfrac{2}{5}$$

$\therefore$ Gain $= 113\tfrac{2}{5} - 100 = \underline{13\tfrac{2}{5}}$. Ans.

2. What sum of money will amount to £1414 12s. 6¾d. in 3½ years at 3¾ per cent. per annum simple interest?

£100 will amount to $100 + 3\tfrac{1}{2} \times 3\tfrac{3}{4} = 113\tfrac{1}{8}$ in a year.

£ £ s. d.

$\therefore$ $113\tfrac{1}{8}$: 1414 12 6¾ :: 100 : Princ.

$= \underline{£1250\ 10s.}$ Ans.

3. A man had £5000 stock in the 3 per cents., and he sold out at $101\tfrac{1}{2}$, and invested the proceeds in 5½ per cent. debentures at $137\tfrac{1}{2}$. Find the increase in his income, brokerage being omitted.

£5000 in 3 per cents. produces $\frac{5000 \times 3}{100} = £150$.

The sale of £5000 produces $\frac{5000 \times 101\frac{1}{2}}{100} = £5075$.

£5075 invested in 5½ per cents. at $137\tfrac{1}{2}$ produces

$$\frac{5075 \times 5\frac{1}{2}}{137\frac{1}{2}} = £203.$$

Change in income $= £203 - £150 = \underline{£53}$. Ans.

4. A, B, and C, each earn 4s. 6d. a day when at work, and nothing when idle, and the average earnings of the three together was 11s. 3d. a day for 12 days. If A was idle 2 days, and B 3 days, how many days was C idle?

		£	s.	d.
Total earnings = 11s. 3d. × 12 =		6	15	0
Earnings of A for 10 days = 4s. 6d. × 10 =	£2 5 0			
,, B ,, 9 ,, = 4s. 6d. × 9 =	2 0 6			
,, A and B =		4	5	6
$\therefore$,, C =		£2	9	6

Which at 4s. 6d. per day $= \frac{49s.\ 6d.}{4s.\ 6d.} = 11$ days.

$\therefore$ C was idle $12 - 11 = \underline{1\ day.}$ Ans.

History.

MALES AND FEMALES.

1. When did William of Normandy conquer England? Give an account of the great battle which he won.

In 1066, Harold had defeated Tostig, and was holding a feast at York, when news arrived that William had landed. This he would not have accomplished if Harold's army in the south had not been disbanded. When the rival armies met, the English occupied a good position on rising ground at Senlac, near Hastings. The impatience of some of the English troops lost the battle. They left their entrenchments to pursue a foe who only pretended flight, and their position was not again successfully attained. The English were also put into confusion by the Normans shooting arrows into the air so as to alight on the heads of their enemies. When Harold had been shot by an arrow, the victory was completed by the slaying of his household troops. Battle Abbey was erected by William to commemorate the victory.

2. How was Scotland treated by our Edwards? What efforts to obtain independence were made by the Scotch?

Edward I. claimed fealty from the Scottish king, and received it from Baliol, who afterwards rebelled. In 1296 Edward took possession of Scotland. Under Wallace the English were defeated at Stirling, but were successful at Falkirk, and Wallace was hanged at Tyburn. Robert Bruce then assumed the crown. Edward's illness and death prevented the re-conquest of the country. Edward II. attempted it, but was defeated at Bannockburn, 30,000 English being slain. Edward III.'s reign began with a Scottish invasion, but he was never able to come near them with his army, so peace was made with them in 1328, one clause of which was that Edward should give up the claim to feudal superiority over the country. Later in his reign the Scots were defeated, and their King, David, taken prisoner at Neville's Cross in Durham. Scotland was entirely independent under Edward IV., V., and VI.

3. How did Henry IV. gain the throne? What opposition was made to him in Wales?

Henry had been banished by Richard II after his quarrel with the Duke of Norfolk. On the death of his father, John of Gaunt, the whole of his possessions were taken by the King. Henry, with a number of followers, returned to claim them; and on landing in Yorkshire was joined by the people to the extent of 60,000 men. Richard feebly maintained his claim, was taken prisoner by Henry, and in London was formally deposed. Henry then claimed and received the crown.

The Welsh had loved Richard, and they rose in rebellion against Henry. Owen Glendower led them, and ravaged the western counties. Henry in vain attempted to overcome them as they retreated to the mountains. Glendower was afterwards assisted by the Percys of Northumberland and by the French, but his power was broken by the Prince of Wales, although Glendower never formally submitted.

Teaching.

To what points would you call the attention of an upper class in writing the following copy:—

Egypt is watered by the Nile.

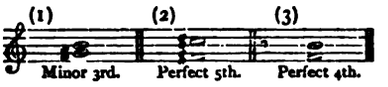
First draw attention to the capital *E*, and show its chief forms. Next direct attention to the fact that there are letters of different heights in the copy, *d*, *b*, and *l* being a height above the line, and *t* only half a height. Then pay particular attention to the looping of the *g* and *y*, and by pattern on the blackboard show that *spacing* must be carefully preserved to make the first word *Egypt* look neat. Notice the necessity of care also in making the capital of the last word.

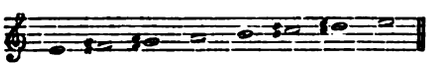
Music.

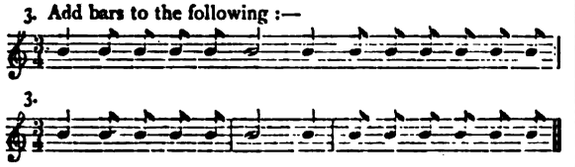
A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write below each of the following intervals its name (major third, &c.) :—

1.

2. Write the scale of E major, placing the necessary sharps before the notes to be sharpened.

2. 

3. Add bars to the following :—

3.

TONIC SOL-FA NOTATION.

1. Write the names of the following intervals :—(1) *te* to *doh*^{1} ; (2) *me* to *doh*^{1} ; (3) *doh* to *lah*.

1. (1) Minor 2nd ; (2) Minor 6th ; (3) Major 7th.

2. What is the mental effect (1) of *me* ; (2) of *soh* ?

2. (1) calm and steady ; (2) grand and bright.

3. Write (1) the pulse-signs for a four-pulse measure ; (2) a six-pulse measure.

3. (1) | : | : ‖ (2) | : : | : : ‖

THIRD YEAR.

Pupil Teachers at end of Third Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including No. 3, if you can.

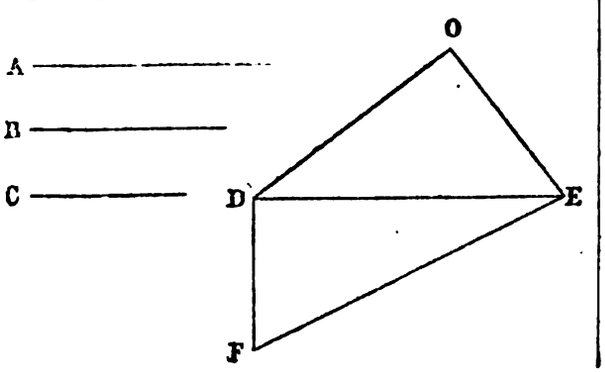
1. If a straight line fall upon two parallel straight lines it makes the alternate angles equal to one another ; and the exterior angle equal to the interior and opposite upon the same side ; and likewise the two interior angles upon the same side together equal to two right angles.

Euclid, Book I., Prop. 29.

2. Parallelograms upon equal bases and between the same parallels are equal to one another.

Euclid, Book I., Prop. 36.

3. Find a square equal to the sum of three given squares, and hence show how to find a square equal to the sum of any number of given squares.



Let A, B, C be three given straight lines.

It is required to describe a square = the sqs. on A, B, and C.

Make OD = A. From point O draw OE = B, and at right ∠'s to OD. Join DE.

Then (I. 47) sq. on DE = sqs. on DO and OE, that is, to sqs. on A and B.

From point D draw DF at right ∠'s to DE and = C. Join FE.

Then (I. 47) sq. on FE = sqs. on FD and DE ; that is, to sqs. on C, A, and B.

Hence, by placing the sides of two sqs. at right ∠'s, a sq. may be described = to them ; by placing the side of *that* sq. at right ∠'s with the side of a third sq., a square may be described equal to three sqs., and so on for any number of squares.

Algebra.

(*Answer two Questions, including No. 2, if you can.*)

1. Find the value of—

$$\frac{30a^2+11ab-28b^2}{6a+7b}-\frac{4a^4b^4+1}{2a^2b^2-2ab+1} \text{ when } a=4,\ b=-3.$$

$$\frac{30a^2+11ab-28b^2}{6a+7b}-\frac{4a^4b^4+1}{2a^2b^2-2ab+1}$$

$$=\frac{30\times16+11\times-12-28\times9}{6\times4+7\times-3}-\frac{4\times256\times81+1}{2\times16\times9-2\times-12+1}$$

$$=\frac{480-132-252}{24-21}-\frac{82081}{313}$$

$$=\frac{96}{3}-265$$

$$=32-265$$

$$=-233. \text{ Ans.}$$

2. *Prove* that $\frac{a}{b}\times c=\frac{ac}{b}$; $\frac{a}{b}\div c=\frac{a}{bc}$; when a, b, c stand for any numbers.

Simplify $\frac{a-b}{ab}-\frac{a-c}{ac}+\frac{b-c}{bc}$

(1) $\frac{a}{b}\times c=\frac{ac}{b}$. For in each of the fractions $\frac{a}{b}$ and $\frac{ac}{b}$ the unit is divided into b parts, and c times as many parts are taken in $\frac{ac}{b}$ as in $\frac{a}{b}$, $\therefore \frac{ac}{b}=c$ times $\frac{a}{b}$

(2) $\frac{a}{b}\div c=\frac{a}{bc}$. For in each of the fractions $\frac{a}{b}$, $\frac{a}{bc}$ the same number of parts (a) is taken, but each part in $\frac{a}{b}$ is c times as large as in $\frac{a}{bc}$, because in $\frac{a}{bc}$ the unit is divided into c times as many parts as in $\frac{a}{b}$ $\therefore \frac{a}{b}\div c=\frac{a}{bc}$

Simplify $\frac{a-b}{ab}-\frac{a-c}{ac}+\frac{b-c}{bc}$

L.C.M. $=abc$.

$$=\frac{(a-b)c-(a-c)b+(b-c)a}{abc}$$

$$=\frac{ac-bc-ab+bc+ab-ac}{abc}$$

$$=0. \text{ Ans.}$$

3. Solve the equations :—

(1) $\frac{1}{2}\left(4+\frac{3x}{2}\right)-\frac{1}{7}(2x-\frac{1}{2})=\frac{11}{28}$.

(2) $\frac{4x}{5-x}-\frac{20-4x}{x}=\frac{15}{x}$

(1) $\frac{1}{2}\left(4+\frac{3x}{2}\right)-\frac{1}{7}(2x-\frac{1}{2})=\frac{11}{28}$

$$1+\frac{3x}{8}-\frac{2x}{7}+\frac{1}{14}=\frac{11}{28}$$

$$168+63x-48x+8=186$$

$$15x=10$$

$$x=\frac{2}{3}. \text{ Ans.}$$

(2) $\frac{4x}{5-x}-\frac{20-4x}{x}=\frac{15}{x}$

L. C. M. $=(5-x)x$.

$4x^2-100+40x-4x^2=75-15x$

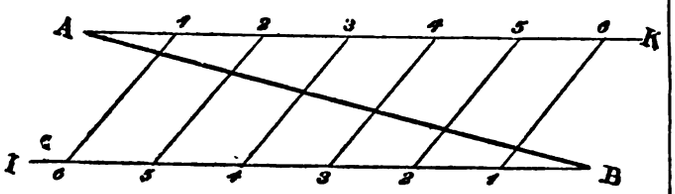
$55x=175$

$x=\underline{3}$. Ans.

Mensuration.

(Answer *one* Question.)

1. To divide a given straight line into 7 equal parts.



Let AB be the given line.

Draw AK at any ∠ with AB. Through B draw BI parallel to AK.

Mark off on AK any length, A1, and repeat it five times, thus, A1, A2, A3, A4, A5, A6.

From B mark off the same distances, B1, B2, B3, B4, B5, B6.

Join A1 B6, A2 B5, etc., cutting AB in C, D, E, F, G, H. AB is divided into seven equal parts at those points.

2. Find the expense of carpeting a room, 18 ft. 9 in. long and 17 ft. 6 in. broad, with carpet 28 inches wide at 5s. 2d. per yard.

No. of yards of carpet required

$$=\frac{18\frac{3}{4}\times 17\frac{1}{2}}{2\frac{1}{3}\times 3}$$

$$=\frac{75}{4}\times\frac{35}{2}\times\frac{3}{7}\times\frac{1}{3}$$

$$=\underline{\underline{43\frac{3}{8}}}\text{ yds.}$$

Cost $=43\frac{3}{8}\times 5\frac{1}{2}$ s.

$=\underline{\underline{£12\ 2s.\ 2\frac{1}{4}d.}}$ Ans.

Arithmetic.

FEMALES.

1. If ·4 of $1\frac{1}{2}$ of an estate be worth £300, what will be the value of $\frac{2\frac{1}{2}}{\frac{5}{14}}$ of the estate?

·4 of $1\frac{1}{2}=\frac{4}{10}\times\frac{3}{2}=\frac{1}{2}$

$\frac{2\frac{1}{2}}{\frac{5}{14}}=\frac{5}{2}\times\frac{14}{5}=7$

£ £

$\frac{1}{2}:7::300:\underline{4,200}$. Ans.

2. A traveller walked 120 miles in 6 days; in each of the first five days he walked an equal distance, in the sixth he walked 17·495 miles; required the number of miles he walked in each of the first *five* days.

		miles.
In 6 days he walked		120
On the sixth	,,	17·495
In the first five	,,	102·505
∴ On each of	,,	,, 20·501 miles. Ans.

3. Divide £471·3756 into 4·74 equal parts, and give your answer in £ s. d. (Work to 4 places of decimals only.)

£

4·74)471·375600(99·4463

4266 — 20

4477 — 8·9260

4266 — 12

2115 — 11·1120

1896

2196

1896

3000

2844

1560

1422 — £99 8s. 11·112d. Ans.

138

4. Reduce $\frac{3}{8}$ of a lb. $+\frac{7}{10}$ of a qr. $+\frac{3}{4}$ of a cwt. to the decimal of a ton.

$$\frac{\frac{3}{8}\text{ lb.}+\frac{7}{10}\text{ qr.}+\frac{3}{4}\text{ cwt.}}{1\text{ ton.}}$$

$$=\frac{\frac{3}{8}+\frac{7}{10}\times\frac{28}{1}+84}{2240}$$

$$=\frac{\frac{3}{8}+\frac{98}{5}+84}{2240}$$

$$=\frac{103\frac{25+18}{30}}{2240}$$

$$=\frac{104\frac{13}{30}}{2240}$$

$$=\underline{\underline{\frac{3133}{67200}}}$$. Ans.

Grammar.

MALES AND FEMALES.

1. Analyse the following, parsing the words in italics:

O how *it yearned my heart*, when I *beheld*,
In London streets *that coronation day*,
When Bolingbroke rode on roan Barbary!
That horse, *that* thou so often hast *bestrid*,
That horse, that I so carefully have dressed!

RICHARD II.

Sentence.	Kind of Sent.	Connective.	Subject.	Predicate.	Object.	Extension.
(*a*)						
O how it yearned my heart,	Prin. S.		It	yearned	my heart	O how (manner)
(*b*)						
when I beheld that horse in London streets that coronation day	Adv. S. (time) to (*a*)	when	I	beheld	that horse	in London streets (place) that coronation day (time)
(*c*)						
when Bolingbroke rode on roan Barbary	Adj. S. to (*b*)	when	Bolingbroke	rode	on roan Barbary (ind.)	
(*d*)						
that thou so often hast bestrid	Adj. S. to (*b*)	In rel.	thou	hast bestrid	that	so often (time)
(*e*)						
that I so carefully have dressed.	Adj. S. to (*b*)	In rel.	I	have dressed	that	so carefully (manner)

It—pers. pro., neut., sing., 3rd, nom. to *yearned*.
yearned—reg. trans. verb, act., ind., past, 3rd, sing., agreeing with its nom. *it*.
my—pers. pro., masc., sing., 1st, poss., gov. by *heart*.
heart—com. noun, neut., sing., 3rd, obj., gov. by *yearned*.
beheld—irreg. trans. verb, act., ind., past, 1st, sing., agreeing with *I*.
that—adj. of distinction, sing. number, qualifying *day*.
coronation—com. noun, used as adj. of qual., qualifying *day*.
day—abs. noun, neut., sing., 3rd, obj., gov. by *on* understood.
that—adj. of distinction, sing. number, qualifying *horse*.
that—rel. pro., masc., sing., 3rd, agreeing with its antecedent *horse*, and gov. by *hast bestrid*.
bestrid—past part. of the verb *to bestride*, forming with *hast* the perf., ind., 3rd, sing. of *to bestride*.

2. What are impersonal verbs? Give examples.

Impersonal verbs are those which are used only in the third person singular with *it* as their nominative. Examples:—It thunders; it rains; it hails; it snows.

3. What is the origin and force of the particle 'be' in 'beheld,' 'bestrid'? Give instances of it as a prefix to *nouns*.

Be is an old English prefix meaning *by*. It is used to make transitive verbs from intransitive; to intensify the meaning of words; to make transitive verbs from adjectives or nouns; and with nouns. Examples:—Behalf, behoof, bequest, behest.

4. Most monosyllabic words are of *English* origin. Point out any exception to this rule in the above.

The word *street*, a monosyllable, comes from the Latin word *strata*.

Geography.

(*Answer two Questions.*)

1. Draw a map of the east coast of Asia, with the adjacent islands.

2. How is the circulation of the waters of the ocean carried on?

Water is expanded and made lighter by heat; it is also contracted and made heavier by cold. The intense heat at the equator and the great cold at the poles thus destroy the balance of pressure on the water; the heavy polar waters sink and flow under the lighter waters of the equator, and the lighter waters of the equator flow over towards the poles. Currents of different strength and dimensions are caused in different parts of the ocean by changes of temperature, and in many cases these currents are assisted by the winds, in many instances blowing steadily in one direction for weeks or months.

3. Give the position and description of any places in Africa we have been hearing about lately.

The places which have been talked of most frequently during the past year are Khartoum, Berber, Dongola, and Suakim.

Khartoum is at the junction of the Blue and White Nile Rivers. It is the modern capital of Nubia, contains from 15,000 to 20,000 inhabitants. It is the centre of the trade of the Eastern Soudan, is at present fortified against the Mahdi by General Gordon.

Berber is about 200 miles N. of Khartoum, a little south of the fifth cataract of the Nile, and near the junction of the Atbara with that river.

Dongola is between the third and fourth cataracts of the Nile, and is as large as Khartoum. Its situation is of importance as a military and commercial depôt.

Suakim is on the Red Sea coast of Nubia, on the same parallel as Berber, from which it is distant about 200 miles.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. Find the true discount on £8175 7s. 6d., due 146 days hence, interest being at 3½ per cent. per annum.

Int. on £100 = $\frac{146}{365} \times \frac{7}{2}$ = £$\frac{7}{5}$

£ £ £ £

∴ 100$\frac{7}{5}$: 8175$\frac{1}{2}$ :: $\frac{7}{5}$: x

= £129. Ans.

2. Find the square root of ·4, and of ·001593606 to 4 decimal places.

$\sqrt{\cdot 4} = \sqrt{\frac{4}{9}} = \frac{2}{3} = \cdot\dot{6}$. Ans.

·001593606(·0399. Ans.

9

69) 693

621

789) 7260

7101

159

3. A man invested £5850 in 3 per cents. at 97⅛, and when the stocks rose to 99⅛ he sold out; what did he gain, a brokerage of ¼ per cent. being charged on each transaction?

He bought 58½ cents. at 97⅛ + ¼ or 97½

He sold 58½ cents. at 99¼ − ¼ or 99½

On every cent. he gained 99½ − 97½ = 2

∴ Total gain = 2 × 58½

= £146 5s. Ans.

4. Two pieces of lead ore weighed 12 and 18 lbs. (avoirdupois) respectively, and the two contained 1½ lbs. of silver. If the bigger contained 6 per cent. of silver, what per cent. of silver did the smaller contain?

Amount of silver in bigger piece

= $\frac{6}{100}$ of 18 = $\frac{27}{25}$ = 1$\frac{2}{25}$ av. lbs.

1$\frac{2}{25}$ lbs. av. = $\frac{27}{25} \times \frac{7000}{7680}$ = 1$\frac{4}{11}$ lbs. Troy.

Amount of silver in smaller piece

= 1½ − 1$\frac{4}{11}$ = $\frac{3}{11}$ lbs. Troy.

$\frac{3}{11}$ lbs. Troy = $\frac{3}{11} \times \frac{7680}{7000}$ = $\frac{27}{175}$ lbs. av.

∴ Percentage of silver in smaller piece =

12 : 100 :: $\frac{27}{175}$: x

= 1$\frac{1}{7}$. Ans.

History.

MALES AND FEMALES.

1. When did the Civil War break out in the reign of Charles I.? Name some of the principal characters and tell the side each espoused.

When Charles set up his standard at Nottingham, on the 22nd of August, 1642. Among the most important characters who were engaged in the war were:—Prince Rupert, Lord Falkland, Earl of Lindsay, Duke of Newcastle, Earl of Montrose, Duke of Hamilton, Prince Charles, and Duke of York, on the side of the king; and Oliver Cromwell, Henry Ireton, Earl of Essex, Sir Thomas Fairfax, John Hampden, Earl of Manchester, Sir William Waller, on the side of the Parliament.

2. What can you tell of the foreign policy of England under Walpole, Chatham, and Pitt?

The policy of Sir Robert Walpole was to keep at peace if possible. He was driven into war with Spain by the embittered feeling of the people against that country, because of the manner in which they tried to check trade with their American colonies. The war was not very successful and Walpole retired from office.

The Earl of Chatham began his political career by joining the 'Patriots' in the House of Commons, and his policy was to make England feared. He could not bear that she should be humiliated, and throughout his career he went to war whenever there was an opportunity. His last speech was in opposition to the surrender of the colonies aided by France.

William Pitt, second son of the Earl of Chatham, was desirous of maintaining peace, but not at the expense of the honour of the country. He prosecuted, therefore, the war with France with vigour, and the success of Napoleon against Austria was to him such a blow as to materially hasten his death.

3. A queen died of small-pox at Kensington Palace about 190 years ago; who was she? Explain the satire in the following lines of that period:—

'There's Mary, the daughter; there's Billy, the cheater;
There's Geordie, the drinker; there's Annie, the eater.'

Mary II., wife of William III.

The lines have reference to Mary, daughter of James II., William III. her husband, George, Prince of Denmark, and his wife Queen Anne. They have reference to the characters of the individuals. Charles II. said of George, 'I have tried him drunk and sober, and there is nothing in him.' Anne was fond of the pleasures of the table. The reference to Mary is in reproof of her ascending the throne of her father, and to William for being the means of the deposition of James II.

Teaching.

Write the notes of a lesson on the Electric Telegraph.

Introduce the lesson by speaking of the means of transmitting messages from place to place, and reference to telegraph wires seen by all scholars. Then give names, magnetic and electric, with their definitions and meanings. Sketch very briefly the history of electricity, and show that the electric telegraph requires three things, the battery, a line, and an indicator.

1. *The Battery.*—For the purpose of producing the power, may be frictional or chemical. Latter chiefly used; a series of copper plates and zinc, arranged in wooden troughs, divided into compartments, and coated with shellac. After introduction of

plates, the cells are filled with sand, and moistened with dilute sulphuric acid. Sketch the battery and plates on blackboard.

2. *The Line.*—Made of galvanized iron wire, suspended on posts, from which the wire is insulated (explain, and why?) by glass or porcelain tubes. Must stretch from place to place between which messages are to be sent.

3. *The Indicator.*—Sketch the multiplier, and show how the needle at the front of the machine is deflected, and that the like instrument at the opposite end of the wire is deflected similarly; letters placed on either side are indicated by different deflections of the needle. Name other instruments and methods of despatching and receiving messages.

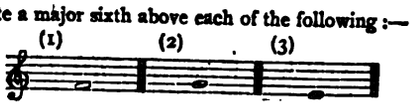
4. *Uses and Benefits.*—To commerce and every condition of life, newspapers, foreign countries.

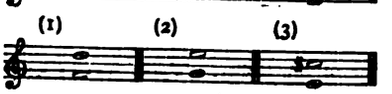
Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write a major sixth above each of the following:—



1. 

2. Re-write the following, doubling the value of every note and rest:—

2.

3. State (briefly) the meanings of the following terms:—(1) *Da Capo*; (2) *pianissimo*; (3) *dolce.*

3. (1) From the beginning; (2) very soft; (3) sweetly.

TONIC SOL-FA NOTATION.

1. Write major sixths above the following:—(1) *doh*; (2) *ray*; (3) *soh.*

1. (1) *lah*; (2) *te*; (3) *me.*

2. What are the five kinds of measure commonly used?

2. Two-pulse; three-pulse; four-pulse; six-pulse; nine-pulse.

3. Explain the following terms:—(1) *Da Capo*; (2) *pianissimo* (3) *dolce.*

3. (1) From the beginning; (2) very soft; (3) sweetly.

FOURTH YEAR.

Pupil Teachers at end of Fourth Year.

FIRST PAPER.

Two hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including No. 2, if you can.

1. To describe a parallelogram that shal be equal to a given triangle, and have one of its angles equal to a given rectilineal angle.

Euclid, Book I., Prop. 44.

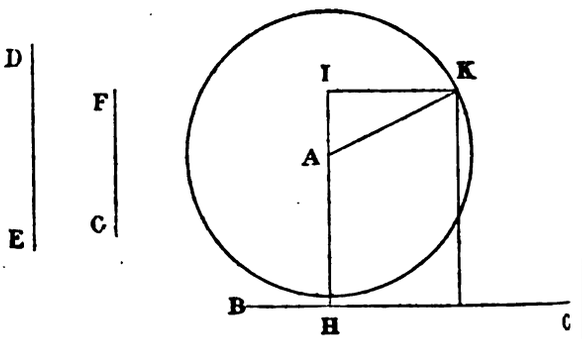
2. If a straight line be divided into any two parts, the squares on the whole line, and on one of the parts, are equal to twice the rectangle contained by the whole and that part, together with the square on the other.

Euclid, Book II., Prop. 7.

3. To find a point at a given distance from a given point, and also at a given distance from a given line.

Show that under certain conditions the problem is impossible.

Let A be the given point, and BC the given straight line. It is required to find a point which shall be at the given distance DE from A, and at the given distance FG from the line BC.



From A let fall a perpendicular AH to BC. On HA, or HA produced, cut off HI=FG. From A with radius AK=DE describe circle K. Through I draw IK parallel to BC, meeting circumference in K.

Draw KL parallel to HI. K is the point required.

KL is parallel to HI, and IK to HL.

∴ KL=HI, and HI=DE. ∴ KL=DE, and AK=FG.

∴ Point K is distant DE from A, and FG from BC.

No point can be found when the combined distances between the point and the given point, and the point and the given line, are less than the distance from the given point to the given line.

Algebra.

Answer two Questions, including No. 2, if you can.

1. Divide $\frac{a^3}{bc}-\frac{2a}{d}+\frac{ac}{be}-\frac{c^2}{de}+\frac{bc}{d^2}$ by $\frac{a}{b}-\frac{c}{d}$

$$\frac{a}{b}-\frac{c}{d}\Big)\frac{a^3}{bc}-\frac{2a}{d}+\frac{ac}{be}-\frac{c^2}{de}+\frac{bc}{d^2}\Big(\frac{a}{c}+\frac{c}{e}-\frac{b}{d}$$

$$\frac{\frac{a^3}{bc}-\frac{a}{d}}{\frac{ac}{be}-\frac{c^2}{de}}$$

$$\frac{\frac{ac}{be}-\frac{c^2}{de}}{-\frac{a}{d}+\frac{bc}{d^2}}$$

$$-\frac{a}{d}+\frac{bc}{d^2}$$

2. State and explain the rule for finding the cube root of an algebraical expression.

Find the cube root of $8a^6x^6-84a^5x^4by^3+294a^4x^3b^2y^6-343b^3y^9$.

Arrange the terms according to the powers of one of the letters, the highest power first; extract the cube root of this term first; subtract; then divide the first term of the remainder by three times the first term of the root squared for the second term of the root; subtract the cube of the sum of the terms thus found, and continue the process till all the terms of the root are found.

For convenience the work can be arranged in three columns as in the following example.

$$
\begin{array}{l|l|l}
8a^2x^6 - 84a^4x^4by^3 + 294a^6x^2b^2y^6 - 343b^3y^9 & & (2a^2x^2 - 7by^3 \\
8a^2x^6 & & \\
\hline
 & -84a^4x^4by^3 + 294a^6x^2b^2y^6 - 343b^3y^9 & \\
 & -84a^4x^4by^3 + 294a^6x^2b^2y^6 & \\
\hline
 & & 12a^4x^4 \quad 6a^2x^2 - 7by^3 \\
 & + (6a^2x^2 - 7by^3)7by^3 & \\
 & 12a^4x^4 + 42a^2x^2by^3 - 49b^2y^6 & \\
\hline
 & - 84a^4x^4by^3 + 294a^6x^2b^2y^6 - 343b^3y^9. &
\end{array}
$$

3. Solve the equations :—

1. $\begin{cases} 45x + 8y = 350 \\ 21y - 13x = 132 \end{cases}$

2. $\dfrac{x+1}{x-1} - \dfrac{x-1}{x+1} = 1.$

In the last, find the roots correct to 2 places of decimals.

1. $45x + 8y = 350$ (1)
$21y - 13x = 132$ (2)

Mult. (1) by 21 and (2) by 8, and subtract

$$945x + 168y = 7350$$
$$-104x + 168y = 1056$$
$$1049x = 6294$$
$$x = 6. \text{ Ans.}$$

Substituting value of x in 2.

$$21y - 78 = 132$$
$$21y = 210$$
$$y = 10. \text{ Ans.}$$

2. $\dfrac{x+1}{x-1} - \dfrac{x-1}{x+1} = 1$

$$(x+1)^2 - (x-1)^2 = (x-1)(x+1)$$
$$(x^2 + 2x + 1) - (x^2 - 2x + 1) = x^2 - 1$$
$$4x = x^2 - 1$$
$$x^2 - 4x = 1$$
$$x^2 - 4x + (2)^2 = 1 + (2)^2$$
$$x - 2 = \pm\sqrt{5}$$
$$x = \pm\sqrt{5} + 2$$
$$= \pm 2{\cdot}23 + 2$$
$$= +4{\cdot}23 : -{\cdot}23. \text{ Ans.}$$

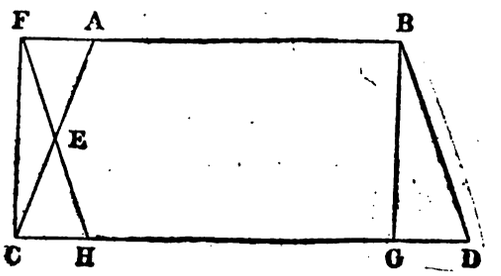
Mensuration.

Answer one Question.

1. State and prove the rule for finding the area of a trapezoid.

Multiply half the sum of the two parallel sides by the perpendicular distance between them, and the product will give the area.

Let ABCD be a trapezoid, of which AB,CD are the parallel sides. The area of ABCD = ½ AB and CD × perpendicular distance BG between them.



Bisect AC in E. Through E draw HF parallel to BD to meet BA produced to F. Draw FC perpendicular to BG.

Then FD is a parallelogram (I. 34), and FB = HD. ∴ FB = half FB,HD.

But AB,CD = FB,HD, for AF = CH (I. 26.)

∴ FB = half AB,CD.

And FD = FG (I. 35). And FG is a rectangle, and its area is found by mult. FB by BG.

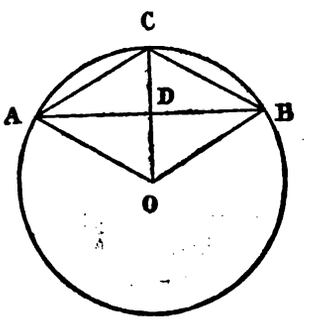
∴ Area of FG = FB × BG.

But ABCD = FG. ∴ Area of ABCD = FB × BG.

But FB = half sum of AB,CD, and BG = perpendicular between them. Wherefore, the area, etc.

2. The radius of a circle is 10 feet; the angle of a sector of it is 120°; find the area of the segment.

AOB = 120°. ∴ AOC = 60°, and AC = AO = 10. ∴ CD, DO are equal, and each = 5.



Area of sector = 360 : 120 :: (·7854 × 20²) = 104·72.

AB = √(10² − 5²)2 = 17·32.

∴ Area of triangle ABO = 17·32 × ⅝ = 43·3.

∴ Area of segment ACB = 104·72 − 43·3

= 61·42 feet. Ans.

Arithmetic.

FEMALES.

1. Find the smallest sum of money that can be divided exactly into shares of £23 16s. 8d. and £31 3s. 4d. each.

£23 16s. 8d.; £31 3s. 4d;

or $23\frac{5}{6}$, $31\frac{1}{3}$.

L.C.M. $= 1\frac{5}{6}^{5} \times 1\frac{3}{6}^{7}$

= £405 3s. 4d. Ans.

2. A wall 1,690 feet long has to be built in 30 days, and it is found that 7 men in 14 days have completed only 490 feet; how many additional men must be employed that the wall may be finished in the required time?

Men to do 490 in 14 days = 7

" " 1 " 1 day $= \dfrac{7 \times 14}{490}$

" " 1200 " 16 days $= \dfrac{7 \times 14 \times 1200}{490 \times 16}$

= 15 men

No. to be added = 15 − 7 = 8 men. Ans.

3. How much money must one invest in the 3 per cent. Consols, when they are at 10 per cent. below *par*, in order to have an income of £2000 a year?

£90 yields £3.
£ £ £ £
∴ 3 : 2000 :: 90 : *x*
= £60,000. Ans.

4. How much per cent. is 1 part out of 8; 7 parts out of 24½; 37 of 75; 43¾ of 165?

8 : 100 :: 1 : 12½. Ans.
24½ : 100 :: 7 : 28⅝. Ans.
75 : 100 :: 37 : 49⅓. Ans.
165 100 :: 43¾ : 26⅔. Ans.

Grammar.

MALES AND FEMALES.

1. Now stir the fire, and *close* the shutters *fast*,
Let *fall* the curtains, *wheel* the sofa *round*,
And while the bubbling and *loud*-hissing urn
Throws *up* a steamy *column*, and the cups
That cheer but not inebriate, *wait* on *each*,
So let us *welcome* peaceful evening *in*.

Analyse the above passage, and parse the words in italics.

ANALYSIS.

Sentence.	Kind of Sentence.	Connective.	Subject.	Predicate.	Object.	Extensn.
(*a*)						
Now stir the fire	Princ. sent.		[you]	stir	the fire	now (time)
(*b*)						
and close the shutters fast	Princ. sent. co-ord. with (*a*)	and	[you]	close	the shutters	fast (manner)
(*c*)						
let fall the curtains	,,		[you]	let	the curtains (dir.) to fall (ind.)	
(*d*)						
wheel the sofa round	,,		[you]	wheel	the sofa	round (manner)
(*e*)						
and so let us welcome peaceful evening in	,,	and	[you]	let	us (dir.) to welcome peaceful evening in so (ind.)	
(*f*)						
while the bubbling and loud-hissing urn throws up a steamy column	Adv. sent. (*time*) to (*e*)	while	the bubbling and loud hissing urn	throws	a steamy column	up (place)
(*g*)						
and the cups wait on each	,,	and	the cups	wait	on each (ind.)	
(*h*)						
that cheer	Adj. sent. to (*g*)	In rel.	that	cheer		
(*i*)						
but not inebriate	Adj. to (*g*)	but	[that]	inebriate		not (neg.)

Close—reg. trans. verb, act., imp., 2nd, plur., agreeing with its nom. *you* understood.
fast—adv. of manner, qualg. *close*.
fall—verb, irreg. intrans., act., inf., pres., gov. by *let*.
wheel—reg. trans. verb, act., imp., 2nd, agreeing with its nom. *you* understood.
round—adv. of manner, qualg. *wheel*.
loud—adj., used as adv. of manner, qualg. *hissing*.
up—adv. of manner, qualg. *throws*.
column—com. noun, neut., sing., obj. case, gov. by *throws*.
that—rel. pro., neut., plur., 3rd, nom. to *cheer*.
cheer—reg. intrans. verb, act., ind., pres., 3rd, plur., agreeing with its nom. *that*.
but—disj. conj., joining the sents. 'That cheer' and 'That inebriate not.'
not—adv. of negation, qualg. *inebriate*.
inebriate—reg. intrans. verb, act., ind., pres., 3rd, plur., agreeing with its nom. *that* und.
wait—reg. intrans. verb, act., ind., pres., 3rd, plur., agreeing with its nom. *cups*.
each—distrib. adj., qualg. *person* understood
so—adv. of manner, qualg. *welcome*.
welcome—reg. trans. verb, act., inf., pres., gov. by *let*.
in—adv. of manner, qualg. *welcome*.

2. From what source is the word 'sofa' derived? Mention other words derived from the same source.

Arabic. Other words:—Alcohol, algebra, bazaar, caravan, divan, emir, fakir, giraffe, harem, jar, magazine, nadir, opium, syrup, tariff, vizier, zenith.

3. To what dates and events would you assign the adoption and discontinuance of French as the language of the Court and nobility in England?

The Normans brought French into England at the invasion in 1066, and it was used by the Court and nobility till the end of the fourteenth century. The loss of our French possessions in John's reign weakened the hold of the nobility on the French language. The strong anti-French feeling engendered in Edward III.'s reign, is given as the cause of its ultimate rejection for English.

4. Name the authors of the following works:—'Paradise Lost,' 'The Faery Queen,' 'Vanity Fair,' 'Robinson Crusoe,' 'The Task,' 'Kenilworth,' 'The Excursion,' 'The Idylls of the King.'

'Paradise Lost' ... John Milton
'The Faery Queen' ... Edmund Spenser
'Vanity Fair' ... ... William Makepeace Thackeray
'Robinson Crusoe' ... Daniel Defoe
'The Task' ... ... William Cowper
'Kenilworth' ... ... Sir Walter Scott
'The Excursion' ... William Wordsworth
'The Idyll's of the King' Alfred, Lord Tennyson

Geography.

(*Answer two Questions.*)

1. Draw a map of the West Indies.

What European nations have possessions there?
Name the colonies belonging to them.
English, French, Dutch, Spanish.

English.—Jamaica, Bahamas, Leeward Is. (Virgin Is., Barbuda, St. Kitts, Nevis, Antigua, Montserrat, Dominica), Windward Is. (St. Lucia, St. Vincent, Barbadoes, Grenada, Tobago), Trinidad.
Spanish.—Cuba, Porto Rico, part of Hayti.
French.—Guadaloupe, Martinique.
Dutch.—Small islands off Venezuela.

2. How would you make a class understand about the seasons?

Use the globe with axis inclined 23½ degrees, and also one with light or a candle to represent the sun. Move the earth, keeping its axis always parallel to itself, round the representation of the sun. Let the earth revolve at the same time that it is moved in its orbit. Draw attention to it first in its position in summer and winter, and the children readily perceive that round about the North Pole great heat and light will be received, while the South Pole is entirely beyond the reach of light or heat from the sun, and *vice versâ*. Move the globe slowly from each of these positions, and show that the amount of heat and light received becomes less or greater as the earth moves from one position to the other. When mid-way between the two draw attention to the fact that both poles receive an equal amount of heat. The use of the globe in this way enables children readily to understand long and short, and equal days and nights, and the variations of the seasons.

3. Give any interesting particulars about the inhabitants or productions of the Torrid Zone.

The inhabitants of the Torrid Zone belong to the darker varieties of the human race, and are generally lower in the scale

of civilization than those of the Temperate Zone. The Torrid Zone is inhabited by the Negro in Africa, and the Malay and Mongolian in Asia. The fruitfulness of the soil and the intense heat prevent the development of the physical and mental powers of the people. The vegetable productions of the Torrid Zone are of a most luxuriant character. The trees are of immense growth, the fruits generally of a luscious character, and the grasses, shrubs, and smaller plants plentiful and varied. Of the trees may be mentioned the banyan, banana, bread-fruit, and palms of various kinds, as well as all the varieties of fancy woods, indiarubber, gutta percha, and other gum trees. The animal productions include all the fierce varieties of wild animals, and the poisonous and venomous snakes; the fish also are of the voracious kind.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. A woman by selling eggs at 5 for 3d. gained 8 per cent.; what per cent. would she have gained if she sold them at 12 for 7d.?

First price of one egg = $\frac{3}{5}$d.
Sec. " " " = $\frac{7}{12}$d.
∴ Selling price = $\frac{3}{5} : \frac{7}{12}$ :: 108 : x = 105
And gain = 105 − 100 = 5 per cent. Ans.

2. A invested a certain sum in 4½ per cent. stocks at 125, and B lent an equal sum at 3¾ per cent. interest; at the end of 12 months A received £5 4s. more dividend than B. What sum did each invest? (Omit brokerage.)

A received as interest
As 125 : 100 :: 4½ : x = 3¾ per cent.
For every £100 he lends, therefore, he gets
£3¾ − 3½ = £$\frac{1}{10}$ more than B.
No. of £100's = $\frac{£5\ 4s.}{£\frac{1}{10}}$ = 52.
∴ Amount lent = £5200. Ans.

3. A and B join in partnership; A puts in the business £300 and B £500; at the end of six months A puts in £400 more and B takes out £100. How should a gain of £61 15s. be divided amongst them at the end of 12 months?

£
A's proportion of capital =
(300 × 6) + (700 × 6) = 6000
B's proportion =
(500 × 6) (400 × 6) = 5400
Total capital = 11400
A's share of profit = $\frac{6000}{11400} \times 61\frac{3}{4} = £32\ 10s.$ Ans.
B's " " = $\frac{5400}{11400} \times 61\frac{3}{4} = £29\ 5s$ Ans.

4. If the circumferences of the two wheels of a bicycle are 48 and 196 inches, after how many turns of each will two points in the circumferences come back into the same relative position?

The larger wheel makes 1 revolution while the smaller makes $\frac{196}{48} = 4\frac{1}{12}$.
The No. of turnings of each before they occupy the same relative position therefore will be
As 1 : $4\frac{1}{12}$
Or 12 : 49. Ans.

History.

MALES AND FEMALES.

1. Compare the power of Parliament under Henry VII., Queen Elizabeth, and William III.

Under Henry VII. the power of Parliament was restricted rather than extended. The nobility had been nearly destroyed during the Wars of the Roses, and Henry was imperious and avaricious. His reign was the commencement of a season of almost despotic rule. Justice was wrested for the purpose of extorting money, and punishments were rigorously enforced, the authority of the Star Chamber being paramount.

Parliament had apparently little more power under Elizabeth than under Henry VII.; but gradually its influence and desires were beginning to be more felt and consulted. Elizabeth, however, yielded gracefully to some of the demands made upon her, and the growing power of Parliament was manifested in the succeeding reign.

Under William III. the power of the Parliament became supreme. Upon the Parliament he depended for his crown. The Bill of Rights provided that the levying of taxes or keeping a standing army without its consent was illegal. Imposition of excessive fines, unnecessary punishments, and the dispensing with laws, were condemned; while the Mutiny Act necessitated Parliament being called together every year.

2. Which was our last possession in France? Give an account of its loss.

Calais was the last of the French possessions held by England. It was lost in the reign of Mary, 1558.

Philip, her husband, who was king of the Netherlands, as well as of Spain, prevailed upon Mary to assist him in a war against France. Calais had been neglected and was left only partially defended. The allies were successful at St. Quentin, in 1557 (August 10th), but the Duke of Guise successfully attacked Calais, and took it on January 7th of the following year. The loss was a great blow to English pride, and it served to break the queen's heart.

3. What are the principal branches of manufacture in the United Kingdom? Describe their rise and progress.

The principal manufactures in the United Kingdom are cotton, woollen, iron, linen, and silk goods.

Cotton was early introduced into this country; but its development as a manufacture began with the invention of the spinning jenny, in 1784, by Hargreaves. Arkwright next invented the water frame, to spin by rollers, and Crompton the mule. With the invention of the power-loom the increase of production was very rapid, till now some 1,200 millions of lbs. of cotton are used annually.

Woollen goods were first manufactured in England in quantities by the Flemings, who settled here in the reign of William I. Each successive king encouraged the manufacture. In Edward III.'s reign it increased rapidly. On the revocation of the Edict of Nantes, 50,000 Huguenots settled here, and the manufacture has since been one of progress. Localities suitable to the trade were selected on account of their facilities for obtaining the raw material. We now import 150 million lbs. of wool yearly, in addition to our own growth.

Linen was not a common manufacture till the invention of the machines above named. The soil of England is not suitable for the growth of flax, which is nearly all procured from the Continent. England imports yearly 150,000,000 lbs. of raw material.

Iron was formerly smelted in the eastern counties; now on all the coal-fields. Great progress has been made during the last century.

Silk-weaving was introduced by the Huguenots, and it is principally to them we owe our manufactures at Coventry, Manchester, and London.

4. 'Peter was first elected Tsar in the spring of 1682, when the Whigs were conspiring against Charles II., three years before the Revocation of the Edict of Nantes, and a year after Strasburg and Alsace had been annexed by Louis XIV., the same year that William Penn was colonising Pennsylvania and La Salle exploring Louisiana.' Give some account of any *two* of the historical events alluded to.

In 1681 a scheme was formed to exclude James from the throne. Monmouth, Russell, Sidney, and other Whigs, concerted measures along with the Scots for risings in several places. Unknown to them the Rye House Plot was also set on foot. It was discovered, and the leaders of the first plot were accused of participation, and several of them (Russell, Sidney, etc.) were beheaded.

The Revocation of the Edict of Nantes was the work of Louis XIV. In 1598 Henry IV. had established by the Edict liberty of worship in France. When it was revoked the lives of Protestants were endangered, and many of them left France and settled in Holland, Belgium, Germany, and England, to the great advantage of the manufacturing industries of all these countries

Teaching.

Write out notes of a lesson on the 'MANUFACTURE OF PAPER.'

1. *Substances used in Manufacture.*

Introduce lesson by noting necessity of communication with absent friends, etc., and early methods of same—writing on *wax tablets*, *bark of trees* (rendered as smooth as possible, *papyrus* (leaves laid side by side and made to adhere), *skins of animals* (soaked in lime-water, cleaned, and smoothed). Present substances—rags, chips, sawdust, straw, grass, cabbage-stalks, almost anything vegetable.

2. *Preparation of Materials and Manufacture.*

Rags procured from every part of the country and world by ragmen (seen by all), sorted, white removed from coloured, cleansed from buttons, hooks and eyes, and other foreign substances; thoroughly washed, placed in cylindrical machine (drum), in which spikes are placed, revolution of machine tears rags to pieces, reduced to pulp. Pulp run on to wire frame, deposited in layers, dried over steam rollers and by fan, wound on to rollers. (Sketch machines on blackboard, or show picture.) Writing-paper glazed, passed through a kind of glue called size; different colours given to it by placing colouring matter in pulp.

3. *Varieties of Paper.*

(*a*) Note paper, made of best white rags, sized well and passed over heated plates. Rolls cut into large sheets by guillotine (sketch), made up into quires of 24 sheets.

(*b*) Brown paper, made of straw, canvas, and other coarse materials.

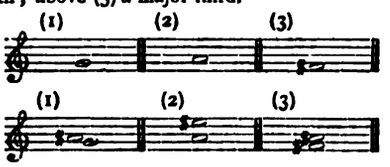
(*c*) Pasteboard and cardboard, several layers of paper glued, fine paper pasted on outside.

Music.

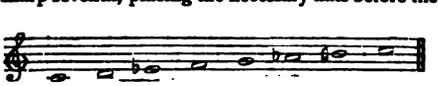
A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

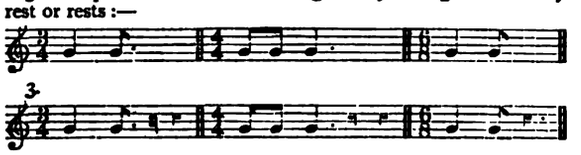
1. Write above (1) an augmented second; above (2) an augmented fifth; above (3) a major third.



2. Write the ascending scale of C minor, using the minor sixth and the sharp seventh, placing the necessary flats before the notes.



3. Complete each of the following bars by adding the necessary rest or rests :—



TONIC SOL-FA NOTATION.

1. Write above (1) *soh* an augmented second; above (2) *ray* an augmented fifth; above (3) *me* a major third.

1. (1) *le*; (2) *le*; (3) *se*.

2. In the minor mode (1) what is the essential sixth; and (2) what is the essential seventh?

2. (1) *bah*; (2) *se*.

3. Re-write the following, doubling the value of every note and rest :—

| m .d : r .,m | s : m ‖

3. | m : d | r :-.m | s :— | m :— ‖

Recent Inspection Questions.

[*The Editor respectfully solicits contributions—all of which will be regarded as* STRICTLY PRIVATE—*to this column. For obvious reasons, it cannot be stated in which district the questions have been set.*]

Arithmetic.

STANDARD I.—(DICTATED).

(1) 789 + 876 + 948 + 67 + 776. Ans. 3,456.
(2) 804 − 138. Ans. 666.
(3) 456 − 369. Ans. 87.

STANDARD II.—(DICTATED).

(1) 63,745 × 86. Ans. 5,482,070.
(2) 32,809 ÷ 7. Ans. 4,687.
(3) 46,310 − 19,708. Ans. 26,602.

STANDARD III.

(1) Divide 52,970,925 by 192.
Ans. 275,890 + 45.

(2) Add £29 1s. 11½d., £507 16s. 10d., £485 7s. 8¼d., £2,690 12s. 3¾d., and £1841 12s. 7½d. Ans. £5,555 5s. 5d.

(3) (Given in words.)—Take £8,389 18s. 10½d. from £9,909 9s. 9d. Ans. £1,519 10s. 10½d.

(4) How many bags of 24 marbles each can be filled from a box which contains 4,800?
Ans. 200.

PROBLEMS.

Card G.—A cut down 340 trees out of 1,002; B cut down half the remainder; C cut down 330. How many were there left? Ans. 1.

Card E.—A man had 30,040 bricks; after selling 15 loads, each containing 550, how many has he yet to sell? Ans. 21,790.

Card H.—There are two vessels, one holds 3 galls., the other 1 gall.; and there is also a well holding a thousand galls. How many galls. are there left after filling each vessel out of the well 250 times?
Ans. None.

STANDARD IV.

(1) Multiply £755 12s. 9¼d. by ninety-two.
Ans. £69,518 14s. 11d.

(2) Divide £528,076 10s. 1¾d. by 527.
Ans. £1,002 0s. 10¼d.

(3) How many persons can each receive 15s. 1d. out of a sum of £40 14s. 6d.? Ans. 54.

(4) In eleven million and twenty-two thousand ounces, how many tons, etc.? Prove your answer.
Ans. 307 tons 10 cwt. 2 qr. 19 lb.

STANDARD V.

(1) Find by practice the cost of 5,908 articles at 16s. 7½d. each. Ans. £4,911 0s. 6d.

(2) 7 cwt. 2 qrs. 19 lbs. 12 ozs. at 25s. 8d. a qr.
Ans. £39 8s. 1¼d.

(3) If a farmer sells 500 sheep at the rate of 4 for £9, how much will he receive? Ans. £1,125.

(4) Make out the following bill—:
37 lbs of tea at 2s. 2¾d. per lb.
49 lbs. of coffee at 1s. 8¼d. a lb.
1½ cwt. of sugar at 5½d. a lb.
690 lbs. of rice at the rate of ¾d. for 20 ounces.
Ans. £13 16s. 8d.

Dictation.

STANDARD I.

All good boys and girls go to school every day.

STANDARD II.

For about one hour she stood thus, till her husband came with a hive. He soon picked out the queen-bee and put it in the hive; and in a short time the whole swarm entered it too, without having done the lady the least harm.

STANDARD III.

The king sat thinking about his poor countrymen, and how he might best deliver them from the Danes, and so he quite forgot all about the cakes. When the herdsman's wife returned to the hut, she found them all black and burnt. She was of course very angry, and told Alfred he was ready enough to eat the cakes but too idle to watch them.

STANDARD IV.

On August 28th, 1782, she was off Portsmouth, having just returned from a cruise. As she was riding quietly at anchor, surrounded by some two or three hundred ships of all kinds, it was discovered that a pipe, used to admit water for cleansing purposes, was out of repair. In order to examine this, it was found necessary that the ship should be heeled over, as the mouth of the pipe was three feet below the surface.

Grammar.

STANDARD II.

Pick out three nouns and three verbs from the piece of dictation.

STANDARD III.

Pick out three nouns, three verbs, three adjectives, three pronouns, and three adverbs from the piece of dictation.

STANDARD IV.

Parse :—

The land-breeze shook the shrouds,
And she was overset.

STANDARD V.

Parse and analyse :—

Thou art come to answer a strong adversary.

STANDARDS VI. AND VII.

(1) Parse and analyse:—

If you have tears, prepare to shed them now.

(2) Point out the word in the above complex sentence which has a Latin prefix, give the meaning of it, and write down other examples.

Composition.

STANDARD VII.

Write an essay on Spring.

Friedrich Fröbel.

BY HIS PUPIL, HEINRICH HOFFMAN.

X.—(*continued.*)

It was not until the year 1840 that the name of Kinder-garten was applied to the new institutions. Fröbel had long been meditating on it. 'One day,' so Barop tells us, 'we—Fröbel, Middendorff, and myself—took a long walk over the *Steiger* to Blankenburg. Fröbel exclaimed repeatedly: "If I but knew a suitable name for my youngest child!" Blankenburg lay at our feet, and in deep meditation he went along. Suddenly he halted, and with beaming eyes, like one inspired, he shouted aloud into the mountains: "*Ευρηκα*! Kinder-garten shall the Institute be named!" and "Kinder-garten!" was echoed from the four quarters of the heavens!'

Shortly after the publication of the *Mutter and Koselieder*, there appeared—*Ein hundert Ball-lieder, zu den in dem Kinder-garten zu Blankenburg ausgeführten Spielen. Musik von R. Kohl.* ('One Hundred Songs to the Games at Ball, as played in the Kinder-garten at Blankenburg'); and also *Zweite Gabe* ('Second gift'); and, in 1844, *Anleitung zum Gebrauch der Dritten Gabe* ('How to use the Third Gift').

The propagation of the Kinder-garten by means of public lectures in every place of note in the south of Germany continued to be the foremost care of the united friends, very often under great personal privations, and all but overwhelming difficulties. Indeed, to us it must appear marvellous how they could have managed to accomplish so much with such scanty means. Fröbel's life from beginning to end was a constant struggle with difficulties and adverse powers, but he never gave way. Pestalozzi's word, written in his album, was always present in his mind, and to it he stuck; come what may, all other things must take their course, *he* must work, work, work incessantly—

'Der Mensch bahnt sich mit der flamme
Des Denkens und mit dem funken des Redens
Den Weg zu seinem Ziel.
Aber er vollbringt diesen Weg
Er vollendet sich selber
Nur durch Schweigen und Thun.'

'With the flame of thought,
With the spark of speech,
Man works his way
To his coveted aim,
But he (achieves his plan), completes this way,
He perfects himself
Only by silence and work.'

That in this way many friends should have been won among all classes of society is quite natural, but as natural, in a man like Fröbel, was the idea to unite what was scattered about here and there and everywhere. From his early life Fröbel's aspirations aimed at unity, and nobody that knew Fröbel at all could feel surprised at another innovation which he was now so eager to introduce, viz., educational societies. Deeply impressed with the necessity and the immense importance of such associations of thoughtful men, more especially of parents, he now devoted all his energy to their realisation. He suggested as their threefold aim: A better acquaintance with the general state of public and private, especially home education, its requirements, and its hindrances; secondly, a consideration of the means and ways of meeting those

requirements; and thirdly, the practical application of the results of such studies. He had the satisfaction to see the formation of several such societies.

It was a subject of sore trouble to him that he found himself compelled to relinquish his favourite work at Blankenburg. Under the fatal impression that such institutions had greater chance of success when worked in a grand style from the very outset, and perhaps confiding too much in the success of his financial operations, he had exceeded his powers. The expected succours failed, the plan had to be given up, and the Kinder-garten was transferred to Keilhau. The training of young women for the Kinder-garten now absorbed all his energy. Many excellent teachers, many exemplary mothers, whose names God's angels have inscribed in the Book of Life, point to Keilhau as the place where the germs of a new spiritual life were laid. One of them, the daughter of Professor Herrmann, in Dresden, who seemed born for the realisation of Fröbel's ideas, married Adolph Frankenberg; under her care the Dresden Kinder-garten soon numbered eighty pupils. Another, Fraulein Louise Levin, of Osterode, so long the residence of Christian, Fröbel's faithful brother, will afterwards claim our particular attention. Gradually the Kinder-garten idea had acquired a great reputation, not only in Thuringia, but throughout the whole of Germany, and Dr. Zeh's prophecy had been verified. The attacks of its adversaries had considerably augmented its fame. Fröbel, therefore, thought it expedient to invite the teachers, and all the friends of education, to a general meeting, in order to a thorough and exact investigation of his system. This meeting took place at Rudolstadt, in the autumn of the year 1848.

It was not, however, simply a meeting; it was a congress, a fiery ordeal through which the work of his life had to pass. Never had the indefatigable old warrior been exposed to such a series of attacks, most of which sprang from sheer ignorance, or merely superficial acquaintance with the subject. Fröbel and his faithful friends stood their ground admirably; and although, as might have been expected, all were not convinced, these were a very small minority, and public opinion pronounced warmly in favour of the system.

The result was a gigantic stride onward, as many persons of great authority were won over, and an enlarged circle of friends invited Fröbel to Dresden, there to give a half-year's course of instruction to mothers, teachers, and others, who felt interested in early education. About this time, Middendorff wrote a most valuable manual, entitled, *Die Kinder-gärten, Bedürfnisz der Zeit, Grundlage einigender Volkserziehung*. This volume, written in a highly interesting and lucid manner, answered the questions, Why should we have Kinder-gartens? What are they? How do they work, and how do they adapt themselves to the requirements of the times? An appendix contains the opinions of eminent men, and original observations. A new edition of this valuable work appeared in Hamburg, 1861, edited by Dr. Wichard Lange.

In October, 1848, Fröbel went to Dresden. A large number of students gathered round him. Fröbel worked as only a man of such physical strength and vigorous intellect can work. He gave three lectures each day, and not only expounded his principles, but also initiated his pupils into the various occupations of the Kinder-garten. It was during this course at Dresden that the writer of this sketch enjoyed the happiness of sitting at the feet of this great benefactor of his race.

Just before the outbreak of the fearful revolution, March, 1849, Fröbel left Dresden, and went to Bad Liebenstein, near Eisenach. The beautiful scenery, the salubrious air, and the far-famed mineral waters, render this place a favourite retreat, not only with Germans, but also with citizens of other countries. It was not unreasonable to expect successful conquests of public opinion by working the system in the presence of wealthy and intelligent visitors. He was not disappointed. He soon found an enthusiastic admirer of his reformatory plans in a lady whose name we cannot mention but with deep reverence, as it will for ever hold a prominent place in the annals of the Kinder-garten. Frau Baronin Bertha von Marenholtz-Bulow had long been disciplined in the school of affliction, and was thus singularly prepared for the sacred mission that awaited her, and for which she seemed particularly destined, the work of which Fröbel opened to her the portals. With deep insight, with restless energy, and with a heart full of love of mankind, and of children in particular, she eagerly entered upon his plans, and has been to this day the foremost promoter and indefatigable friend of the Kinder-garten. She has been an eloquent and able advocate among the aristocracy and the learned, and her numerous writings form a most important and invaluable part of the literature of the system. Unfettered by family ties, her children being in their own spheres of labour, she has devoted her fortune, her rank and position, her whole life, to the service of what she considered her special mission. Who that is even but slightly acquainted with the movement, has not heard the name of the Baroness von Bulow as the chief among German ladies engaged in the sacred work of primary education?

Another friend made by Fröbel in Liebenstein was Adolph Diesterweg, the present Director of the Royal Seminary for Teachers in Berlin, an educationist whose name most deservedly stands in very high esteem among the teaching profession in Germany. He will ever be remembered as a champion for the liberty of thought, of pure and noble character, and as the chief leader of our time in raising the 'school' in Germany to its present high standard.

Diesterweg was so fascinated with Fröbel that he daily attended his lessons, and confessed himself as exceedingly fortunate in being allowed to be a student at the feet of so great, so rare, and so noble a man. He proved to be his staunchest adherent, and he devoted his enormous influence continuously to the spread and development of the Kinder-garten.

The following winter Fröbel acceded to the call of a ladies' society in Hamburg, to hold a half-year's course similar to that given in Dresden. Middendorff accompanied him, and the new movement made rapid progress in the ancient Hanse city. Fröbel inaugurated there the first national Kinder-garten, the *Bürger Kinder-garten* (bürger, citizen), where, at a small cost, the children of the poorer classes might enjoy the benefits of the system. Gradually this has grown to nine separate institutions, all under one association, and each of them having an attendance of at least a hundred children.

(To be continued.)

Query Column.

RULES.

1. Each correspondent is restricted to *one question.* We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.

2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.

3. ☞ When a pseudonym is adopted it should be written at the end of the query, and the real name and address on a separate piece of paper.

4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.

5. Replies will not be sent through the post.

6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—'*The Query Editor*,' *The Practical Teacher*, *Pilgrim Street, Ludgate Hill, London, E.C.*

Arithmetic.

1. JOHN LYLE MARTIN.—A man started with a shilling in his pocket. He gambled and won twice as much as he had. He gambled again, and lost ⅔ of what he then had all but 9d. How much had he then left? Represent your answer as the decimal of a pound.

Amount after first play = 1s. + 2s.
= 3s.;
,, ,, second ,, = ⅓ of 3s. + 9d.
= 1s. 9d.
$= \frac{21}{20}$£
$= \frac{7}{80}$£
= £·0875. Ans.

Note.—Each correspondent is restricted to one question. *Vide* Rule 1 Query Column.

2. INQUISITIVE.—What quantity of each of two sorts of coffee, one at 10d. and the other at 1s. 10d., will when mixed be worth 1s. 2d. per lb.?

Gain on first kind = 1s. 2d. − 10d. = 4d.;
Loss ,, second ,, = 1s. 10d. − 1s. 2d. = 8d.;
∴ Quantity at 10d. : quantity at 1s. 10d. :: 8d. : 4d.
:: 2 : 1. Ans.

Note.—Your writing is *very fair*, but *too straight.*

3. J. THOMPSON.—Which would be the better investment, 3 per cent. stock at 87⅜, or shares at £233 each, on each of which a dividend of £7 13s. 4d. is paid annually? (*Barnard Smith.*)

Income on £1 in first case $= \frac{3}{87\frac{3}{8}}$£
$= \frac{24}{699}$£;
,, ,, second ,, $= \frac{7\frac{2}{3}}{233}$£
$= \frac{23}{699}$£;

∴ The 3 per cents. at 87⅜ is the better investment.

NOTE.—Each correspondent is restricted to one question. See Rule 1 Query Column.

4. MONITOR.—A tradesman's prices are 25 per cent. above cost price. If he allows a customer 12 per cent. on his bill, what profit does he make? (*All the year round Test Cards.*)

Profit on £100 = £25 − 12 per cent. on £125
= £25 − £15
= £10;
∴ Profit = 10 per cent. Ans.

5. MAGISTER.—A tradesman imported a quantity of foreign goods, for which he had to pay a duty of 15 per cent., but the demand for them having gone off he is obliged to sell at a loss of 5½ per cent.; a month earlier he could have sold them for £124 4s. more, and then would have cleared at 2½ per cent. on the transaction; what price did he pay for the goods? (*Barnard Smith's* '**Examination** Questions in Arithmetic.')

Difference of profits on £100 cost price
= (5½ + 2½) per cent. on £115
= 8 per cent. on £115
$= \left(\frac{\overset{23}{115}}{1} \times \frac{\overset{3}{8}}{\underset{7}{100}}\right)$£
$= £\frac{92}{7}$;
£ £ £
∴ $\frac{92}{7}$: 124½ :: 100 : Cost price of goods.
$= \left(\frac{\overset{9}{18}}{\underset{1}{5}} \times \frac{\overset{20}{100}}{1} \times \frac{7}{\underset{1}{35}}\right)$£
= £1,260. Ans.

6 ECCLESBOURNE.—£10,000 in 3½ per cents. is left free of legacy duty to an almshouse for the support of 13 bedesmen. This sum is sold out and re-invested in 4 per cents. at par, legacy duty and transfer expenses amounting to 11¼ per cent. The bedesmen, when the arrangements are completed, receive each £25 2s. 5$\frac{7}{13}$d. a year. What was the selling price of the 3½ per cents.? (*Moffatt's* 'Pupil Teachers' Cards.')

Income = £25 2s. 5$\frac{7}{13}$d. × 13
= £326 12s.;
Amount invested = £326 12s. × $\frac{100}{4}$
= £326 12s. × 25
= £8,165;
Amount of stock transferred = £10,000 − (£11¼ × 100)
= £10,000 − £1125
= £8875;
£ £ £
∴ $\frac{\overset{355}{8875}}{355}$: $\frac{\overset{4}{100}}{4}$ :: $\frac{\overset{23}{8125}}{23}$: Price of 3½ per cents.
= £92.
∴ Price of the 3½ per cents. = 92. Ans.

Note.—Perhaps 80 per cent.

7. LEO.—A person has 4 houses, the united values of which amount to £1,840. The value of the first house is two-thirds of the second, that of the second is three-fourths of the third, and the value of the third is five-sixths of the fourth house: find the value of each. (*Barnard Smith.*)

Value of 3rd house = $\frac{5}{6}$ of value of 4th house;
,, 2nd ,, = $\frac{3}{4}$,, 3rd ,,
= $\frac{\overset{2}{3}}{4}$ of $\frac{5}{6}$,, 4th ,,
$= \frac{5}{8}$,, ,, ,,;
,, 1st ,, = $\frac{2}{3}$,, 2nd ,,
= $\frac{2}{3}$ of $\frac{5}{8}$,, 4th ,,
$= \frac{5}{12}$,, ,, ,,;

∴ Value of 4th house × (1 + ⅝ + ⅝ + 5/12) = £1840,
,, ,, ,, × $\frac{24+20+15+10}{24}$ = ,,;
,, ,, ,, × 3$\frac{1}{24}$ = £1840,

∴ Value of 4th house $= £\overset{80}{\cancel{1}\cancel{6}\cancel{4}\cancel{0}} \times \frac{8}{\cancel{8}}$
$= £640$;
" 3rd " $= \frac{5}{8}$ of £640
$= £533$ 6s. 8d.;
" 2nd " $= \frac{4}{8}$ of £640
$= £400$;
" 1st " $= \frac{3}{8}$ of £640
$= £266$ 13s. 4d.

8. LIVERPUDLIAN.—Simplify:—

$3\frac{1}{16}$ of $\frac{2\cancel{2}\cancel{4}}{2\cancel{5}\cancel{7}} \div 71 + 2\frac{3}{16}$ of $\frac{1}{16}$ of $\frac{1}{16} - \frac{1}{16}$ of $1\frac{1}{16}$. (*Piper.*)

$$3\tfrac{1}{16} \text{ of } \tfrac{2\cancel{2}\cancel{4}}{2\cancel{5}\cancel{7}} \div 71 + 2\tfrac{3}{16} \text{ of } \tfrac{1}{16} \text{ of } \tfrac{1}{16} - \tfrac{1}{16} \text{ of } 1\tfrac{1}{16}$$
$$= \frac{\overset{8}{\cancel{8}}\cancel{1}}{\cancel{1}\cancel{6}} \text{ of } \frac{\overset{2}{\cancel{4}}\cancel{2}\cancel{8}}{\cancel{4}\cancel{2}\cancel{7}} \times \frac{1}{71} + \frac{\overset{11}{\cancel{1}\cancel{4}\cancel{2}}}{70} \text{ of } \frac{3}{\cancel{8}\cancel{8}} \text{ of } \frac{\cancel{8}}{\cancel{4}\cancel{4}} - \frac{7}{\cancel{1}\cancel{9}\cancel{6}} \text{ of } \frac{9\cancel{8}}{\cancel{8}\cancel{4}}$$
$$= \frac{3}{\cancel{7}\cancel{1}} + \frac{1}{\cancel{7}\cancel{1}\cancel{0}} - \frac{1}{\cancel{7}\cancel{1}}$$
$$= \frac{40 + 9 - 35}{840}$$
$$= \frac{\cancel{1}4}{\cancel{8}\cancel{4}\cancel{0}}$$
$$= \underline{\frac{1}{\cancel{6}\cancel{0}}}. \text{ Ans.}$$

9. DISAPPOINTED.—A, B, and C run a quarter of a mile race. A has 3 yards' start, and B 2 yards. C gains one foot in 40 yards throughout on A. B gains 2 ft. in 25 yds. on A for the first 200 yds., and then loses 1 foot in 20 yds. What is the result of the race?

C's gain on A $= \frac{44\cancel{0}}{4\cancel{0}}$ ft. $= 11$ ft.;
∴ C is 11 ft. − 3 yds., or 2 ft. in front of A;
B's gain on A $= (\frac{2\cancel{0}\cancel{0}}{2\cancel{5}} \times 2)$ ft. $- \frac{22\cancel{0}}{2\cancel{0}}$ ft.
$= 16$ ft. $- 11\frac{2}{10}$ ft.
$= 4\frac{1}{10}$ ft.;
∴ B is $4\frac{1}{10}$ ft. − 1 yd., or $1\frac{1}{10}$ ft. in front of A;
∴ Result is:—
C first, 2 ft. in front of A., and $\frac{2}{10}$ ft. before B; B second, $\underline{1\frac{1}{10}}$ ft. in front of A.

10. HOPEFUL.—A train 88 yards in length overtook a person walking along the line at the rate of 4 miles an hour, and passed him in 10 seconds. Twenty minutes after the train overtook another person, and passed him in 9 seconds. When will the last person overtake the first? (*Barnard Smith.*)

Distance walked by last person in 10 seconds
$= \left(\frac{1\cancel{0}}{\cancel{8}\cancel{0} \times \cancel{8}\cancel{0}} \text{ of } \cancel{4} \times 176\cancel{0}\right)$ yds.
$= 17\frac{3}{8}$ yds.
$= 19\frac{3}{8}$ yds.;
Distance travelled by train in 10 seconds
$= (88 + 19\frac{3}{8})$ yds.
$= 107\frac{3}{8}$ yds.;
Distance travelled by train in 9 seconds
$= (107\frac{3}{8} \times \frac{9\cancel{0}}{10})$ yds.
$= \frac{9,66\cancel{2}}{1\cancel{0}}$ yds.
$= 96\frac{3}{4}$ yds.;
∴ Distance walked by first person in 9 seconds
$= (96\frac{3}{4} - 88)$ yds.
$= 8\frac{3}{4}$ yds.;
∴ Rate per hour of first person
$= \left(8\frac{3}{4} \times \frac{60 \times 60}{9}\right)$ yds.
$= \left(\frac{\overset{2}{\cancel{4}\cancel{4}}}{\cancel{8}} \times \frac{\overset{1}{\cancel{4}\cancel{0}\cancel{0}}}{\cancel{1}\cancel{7}\cancel{6}\cancel{0}}\right)$ miles
$= 2$ miles;

Distance between the two persons when the train overtook the first person
$= \left(107\frac{3}{8} \times \frac{60 \times 20}{10}\right)$ yds. $- \frac{22}{\cancel{8}\cancel{0}}$ of $(4 - 2)$ miles
$= \left(\frac{\overset{22}{\cancel{9}\cancel{8}\cancel{8}}}{\cancel{9}} \times \frac{\overset{3}{\cancel{3}}\cancel{2}\cancel{0}}{\cancel{1}\cancel{7}\cancel{6}\cancel{0}}\right)$ miles $- \frac{1}{8}$ of 2 miles
$= 7\frac{3}{4}$ miles $- \frac{2}{8}$ mile
$= 6\frac{3}{4}$ miles;
∴ Time last person will overtake the first after train has passed first person
$= (6\frac{3}{4}$ miles $\div 2$ miles) hours
$= \frac{1\cancel{0}}{\cancel{4}}$ hours
$= \underline{3\frac{1}{2}}$ hours. Ans.

11. INQUISITIVE.—Given the rate of exchange as 25·22 francs per £ sterling, and that 4·54 litres are equivalent to one gallon—deduce the number of francs per litre equivalent to one shilling per gallon. (*Edinburgh University Senior Local Exam.*, 1884-5.)

Quantity for £1 = 20 gals.
$= (20 \times 4{\cdot}54)$ litres;
Quantity for 25·22 francs $= (20 \times 4{\cdot}54)$ litres;
∴ Price per litre $= \frac{\overset{12{\cdot}61}{\cancel{2}\cancel{5}{\cdot}\cancel{2}\cancel{2}}}{\overset{10}{\cancel{2}\cancel{0}} \times 4{\cdot}54}$ of a franc
$= \frac{12{\cdot}61}{45{\cdot}4}$ of a franc
$= \underline{{\cdot}27775\ldots}$ of a franc. Ans.

12. P. T. L.—If the estimated value of the property in a certain parish consist of the yearly rent paid to the landlord together with the rates, and the rates be calculated upon the rent after a reduction of 30 per cent., find the rateable value of a tithe-rent charge, the estimated annual value of which is £884, when the rates amount to 3s. in the pound. (*Barnard Smith.*)

Estimated annual value = Rent + Rates;
∴ £884 = Rent + Rates
= Rent + Rate on (Rent − 30% of Rent)
= Rent + Rate on $\frac{7}{10}$ of Rent
= Rent + Rate of 3s. in the £ on $\frac{7}{10}$ of Rent
= Rent + $\frac{3}{20}$ of $\frac{7}{10}$ of Rent
= Rent + $\frac{21}{200}$ of Rent
= $\frac{221}{200}$ of Rent;
∴ Rent = £884 $\div \frac{221}{200}$
= £800;
∴ Rateable value = $\frac{7}{10}$ of £800
= $\underline{£560}$. Ans.

13. CURIOUS.—If a concert costing £25, and attended by 250 people, produce a profit of £4 1s. 7d., what would be the profit of one costing £10 more, attended by $\frac{1}{5}$ more people at $\frac{1}{5}$ higher prices? (*Davis.*)

Amount realised by second concert
$= £(25 + 4\frac{8}{17}) \times \frac{\overset{2}{\cancel{6}}}{5} \times \frac{4}{\cancel{8}}$
$= £29\frac{8}{17} \times \frac{3}{2}$
$= (£\frac{5\cancel{0}\cancel{1}}{17} \times \frac{3}{2})$
$= £\frac{4\cancel{0}\cancel{1}}{\cancel{3}\cancel{4}}$
$= £47$ 18s. $1\frac{7}{17}$d.;
∴ Profit of second concert $= £47$ 18s. $1\frac{7}{17}$d. $- (£25 + £10)$
$= £47$ 18s. $1\frac{7}{17}$d. $- £35$
$= \underline{£12}$ 18s. $1\frac{7}{17}$d. Ans.

Note.—Perhaps 90 per cent.

14. COLUMBA.—If, when 25 per cent. is lost in grinding wheat, a country has to import ten million quarters, but can maintain itself on its own produce, if only 5 per cent. be lost, find the quantity of wheat grown in the country. (*Barnard Smith.*)

Quantity grown = Ten million quarters $\times \frac{100}{25 - 5}$
= " " " $\times \frac{1,\cancel{0}\cancel{0}\cancel{0}}{2\cancel{0}}$
= " " " $\times 5$
= $\underline{\text{Fifty million quarters.}}$ Ans.

15. FRANCHISE.—A dishonest publican uses measures which are false to the extent of 5 per cent.; but his brewer gave him in every barrel only 35 gallons. The publican buys at 21s. the barrel, and sells at 2d. the pint; what does he gain in a year when he bought 950 gallons? (*Piper.*)

Gain on a barrel $= [\{(35 \times 8) \div \frac{35}{100}\} \times 2]$d. $- 21$s.
$= \left(2\frac{2\cancel{6}}{1} \times \frac{\overset{10}{\cancel{2}\cancel{6}}}{19} \times \frac{1}{\cancel{6}}\right)$s. $- 21$s.
$\overset{3}{}$

$$= \frac{2800-1197}{57}\text{s.} - 21\text{s.}$$
$$= \frac{1603}{57}\text{s.};$$

$$\therefore \text{Gain on 950 barrels} = \left(\frac{1603}{57} \times \frac{950}{1}\right)\text{s.}$$
$$= \frac{80150}{3}\text{s.}$$
$$= 26{,}716\tfrac{2}{3}\text{s.}$$
$$= \underline{£1{,}335\ 16\text{s. } 8\text{d.}}\ \text{Ans.}$$

16. F. S.—A person sells out of the new 3 per cents. at $93\frac{1}{8}$ as much stock as produces £26,893 6s. At what price must the Turkish 6 per cents. be, in order that by investing the proceeds in it, he may increase his income by £200 a year, taking brokerage into account? (*Clark's* 'Civil Service Arithmetic.')

£ £ s. £
$93\frac{1}{8}$: 26893 6 :: 1900 : Amount of stock sold out.
20 20 20
1865 537800
373 1442

$= \underline{£28{,}840 \text{ stock.}}$

Income from Turkish 6 per cents.
= 3 per cent. on £28,840 + £200
= £865 4s. + £200
= £1065 4s.

£ s. £ £ s.
∴ 1065 4 : 8 :: 26893 6 : Price of Turkish stock
20 3 20 with brokerage.
21304 80679
5326 5326
27419
26630
7899
5326
2573

∴ Price of Turkish 6 per cents.
$= 151\frac{10292}{21304} - \frac{1}{8}$
$= 151\frac{10292-2663}{21304}$
$= \underline{151\frac{7629}{21304}}$. Ans.

Algebra

1. ASSISTANT.—Solve:—

$$2^{x+1} + 4^x = 80. \quad (\textit{Todhunter.})$$

$$2^{x+1} + 4^x = 80$$

(Put y for 2^x)
Then, $2y + y^2 = 80$
$y^2 + 2y + 1 = 81$
$y + 1 = \pm 9$
$\therefore \underline{y = 8, \text{ or } -10.}$
$\therefore 2^x = 8, \text{ or } -10,$
so that $\underline{x = 3.}$

2. REX.—A house of 11 boys contains 6 who can only row, and 3 who can only steer; the other 2 can do either. How many different crews can they form for their four-oar? (*Dalton.*)

No. of crews from the 6 who can only row and from the 3 who can only steer $= \frac{6.5.4}{1.2.3} \times 3$
$= 60;$

No. of crews from the 6 who can only row and from the 2 who can do either to steer $= \frac{6.5.4}{1.2.3} \times 2$
$= 40;$

No. of crews from 2 out of the 6 who can only row, from the 2 who can do either, and from the 3 who can only steer $= \frac{6.5}{1.2} \times 2 \times 3$
$= 90;$

No. of crews from 2 out of the 6 who can only row and from the 2 who can do either, 1 to steer and 1 to row $= \frac{6.5}{1.2} \times 2$
$= 30;$

No. of crews from 1 out of the 6 who can only row, from the 2 who can do either, and from the 3 who can only steer $= 6 \times 3$
$= 18;$

∴ No. of different crews = 60 + 40 + 90 + 30 + 18
$= \underline{238.}$

3. E. P. JONES.—Prove that in taking the square root of a number when $n+1$ digits in the root have been obtained by the ordinary rule, n more may be determined by simple division. (*Certificate*, 1883.)

Let N represent the no. whose square root is required, a the part of the root already obtained, and x the part which remains to be found; then

$$\sqrt{N} = a + x,$$
Squaring, $$N = a^2 + 2ax + x^2,$$
$$N - a^2 = 2ax + x^2,$$
$$\frac{N-a^2}{2a} = x + \frac{x^2}{2a}.$$

Thus $N - a^2$ divided by $2a$ will give the rest of the square root required, or x, increased by $\frac{x^2}{2a}$, and $\frac{x^2}{2a}$ is a proper fraction, so that by neglecting the remainder arising from the division we obtain the proof required.

For x by supposition contains n digits, so that x^2 cannot contain more than $2n$ digits; and a contains $n+1$ digits, therefore $\underline{\frac{x^2}{2a} \text{ is a proper fraction.}}$

4. JULIUS CÆSAR.—Solve:—

$$x + y = 7(x - y),\ x^2 + y^2 = 100.$$

—(*Todhunter's* 'Algebra for Beginners.')

(1) $x + y = 7(x - y)$
(2) $x^2 + y^2 = 100$
(1) $x + y = 7(x - y)$
$= 7x - 7y$
$8y = 6x$
$\therefore \underline{y = \frac{3x}{4}}.$

Substituting this value of y in (2): (2) $x^2 + \left(\frac{3x}{4}\right)^2 = 100$

$$x^2 + \frac{9x^2}{16} = 100$$
$$\frac{25x^2}{16} = 100$$
$$x^2 = 64$$
$$\therefore \underline{x = \pm 8.}$$
$$y = \frac{3x}{4}$$
$$= \frac{\pm 8 \times 3}{4}$$
$$= \underline{\pm 6.}$$

Note.—Various artifices are employed in solving 'Simultaneous Equations involving quadratics,' and the proper application of the different methods must be learned by experience. The simplest method is by substitution, as in the given example.

5. C. J. S.—Solve:—

$$\sqrt{x^2 - 6x + 16} + (x - 3)^2 = 13. \quad (\textit{Todhunter.})$$
$$\sqrt{x^2 - 6x + 16} + (x - 3)^2 = 13$$
$$\sqrt{x^2 - 6x + 16} + (x^2 - 6x + 9) = 13$$

Adding 7 to each side:
$$(x^2 - 6x + 16) + \sqrt{x^2 - 6x + 16} = 13 + 7$$
$$= 20$$

Completing the square:
$$(x^2 - 6x + 16) + \sqrt{x^2 - 6x + 16} + (\tfrac{1}{2})^2 = 20 + \tfrac{1}{4}$$
$$= \tfrac{81}{4}$$
$$\sqrt{x^2 - 6x + 16} + \tfrac{1}{2} = \pm \tfrac{9}{2}$$
$$\sqrt{x^2 - 6x + 16} = \pm \tfrac{9}{2} - \tfrac{1}{2}$$
$$= 4, \text{ or } -5$$

Squaring each side, $x^2 - 6x + 16 = 16, \text{ or } 25;$
$x^2 - 6x + 16 = 16$
$x^2 - 6x = 0$
Dividing each side by x, $x^2 = 6x$
$\therefore \underline{x = 6};$

And as we divide each side by x, therefore the value $x = 0$ satisfies the equation.

From, $x^2-6x+16=25$, surd values of x are obtained, and they do not satisfy the equation.

$\therefore$ $x=0$, or 6.

6. J. EDWARDS.—Divide 418·9666 by 6·289 in scale of 12. Reduce 296·7 from scale of 12 to that of 10. Find value in decimals of ·15 in the scale of 7. (*Lower Division*, February, 1883.)

(1) 6·289) 418·9666 (7 *c. t.* Ans.
377 13
61 836
58 603
5 2336
5 2336

(2) 10 | 206 ·7 in scale of 12
10 | 34...2 $=\frac{7}{12}$ in scale of 10
4...0 $=$ ·583;

$\therefore$ 296·7 in scale of 12 = 402·583 in scale of 10.

(3) ·15 in scale of 7

$$=\frac{1}{7}+\frac{5}{7^2}+\frac{5}{7^3}+\frac{5}{7^4}\ldots\ldots\ldots$$

Here the terms after the first constitute an infinite Geometrical Progression, of which the first term is $\frac{5}{7^2}$, and the common ratio is $\frac{1}{7}$.

Sum of an infinite geometrical series

$$=\frac{a}{1-r}$$
$$=\frac{5}{7^2}\div\left(1-\frac{1}{7}\right)$$
$$=\frac{5}{7^2}\div\frac{6}{7}$$
$$=\frac{5}{7\times 6}$$
$$=\frac{5}{42};$$

$\therefore$ ·15 in scale of 7 $=\frac{1}{7}+\frac{5}{42}=\frac{11}{42}$
$=$ ·26190476 in common scale.

Note.—The subject of 'Scales of Notation' is generally contained in works on Algebra.

7. E. H. COUMBE.—'The square of any real number, positive or negative, is always positive':—Hence show that $a^2c^2+b^2d^2$ is always greater than $2abcd$, and that $\frac{(ac+bd)^2}{(a^2+b^2)(c^2+d^2)}$ is always a proper fraction, whatever values may be assigned to a, b, c, d.

$(ac-bd)^2$ always gives a positive quantity,
$\therefore$ $(a^2c^2-2abcd+b^2d^2)$, = positive quantity,
$\therefore$ $a^2c^2+b^2d^2>2abcd$.

Note.—When $ac=bd$, then $a^2c^2+b^2d^2=2abcd$.

$$\frac{(ac+bd)^2}{(a^2+b^2)(c^2+d^2)}$$
$$=\frac{a^2c^2+2abcd+b^2d^2}{a^2c^2+a^2d^2+b^2c^2+b^2d^2}$$
$$=\frac{(a^2c^2+b^2d^2)+2abcd}{(a^2c^2+b^2d^2)+(a^2d^2+b^2c^2)}$$

Now, if $ac=bd$, ad cannot equal bc,
$\therefore$ $a^2d^2+b^2c^2>2abcd$ (as above)

$\therefore$ $\frac{(ac+bd)^2}{(a^2+b^2)(c^2+d^2)}$ is always a proper fraction.

8. R. R. P.—The population of a town increases annually by 4 per cent.; what proportionate addition to the population will be made in a period of 10 years?

N.B. Log. 1·04 = ·017033;
log. 1·48 = ·170330. (*Certificate*, 1883.)

Population at end of 10 years = Population at beginning of 1st year $\times (1\cdot04)^{10}$
= Population × No. corresponding to log (10 times log. 1·04)
= Population × No. corresponding to log. (·017033 × 10)
= Population × No. corresponding to log. ·170330
= Population × 1·48;
$\therefore$ Proportionate addition = ·48 = $\frac{12}{25}$.

Note.—It is not necessary to take Mental Arithmetic, but if you do it will increase the number of marks.

9. ANFEDRUS.—Prove by induction or otherwise the sum of the series

$$1^3+2^3+\ldots\ldots+m^3=\frac{m^2(m+1)^2}{4}.$$

—(*Certificate*, 1883.)

Let s denote the required sum; then

$$s=1^3+2^3+\ldots\ldots+m^3;$$

We have

$$m^4-(m-1)^4=4m^3-6m^2+4m-1,$$
$$(m-1)^4-(m-2)^4=4(m-1)^3-6(m-1)^2+4(m-1)-1,$$
$$(m-2)^4-(m-3)^4=4(m-2)^3-6(m-2)+4(m-2)-1,$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$
$$3^4-2^4=4\cdot3^3-6\cdot3^2+4\cdot3-1,$$
$$2^4-1^4=4\cdot2^3-6\cdot2^2+4\cdot2-1,$$
$$1^4-0^4=4\cdot1^3-6\cdot1^2+4\cdot1-1;$$

Hence, by addition,

$$m^4=4\{1^3+2^3+\ldots\ldots+m^3\}$$
$$-6\{1^2+2^2+\ldots\ldots+m^2\}$$
$$+4\{1+2+\ldots\ldots+m\}-m;$$

The sum of the squares of the first m natural numbers

$$=\frac{m(m+1)(2m+1)}{6};$$

The sum of the first m natural numbers $=\frac{m}{2}(m+1)$;

That is, $m^4=4s-m(m+1)(2m+1)+2m(m+1)-m$
$=4s-2m^3-3m^2-m+2m^2+2m-m$
$=4s-2m^3-m^2$,
$4s=m^4+2m^3+m^2$
$=m^2(m^2+2m+1)$
$=m^2(m+1)^2$
$\therefore$ $s=\frac{m^2(m+1)^2}{4}$.

10. J. HOLTON.—Solve:—

$$\left.\begin{array}{l}(x+5)^2+(y-6)^2=2(xy-24)\\ y=x+1\end{array}\right\}\ (Colenso.)$$

(1) $(x+5)^2+(y-6)^2=2(xy-24)$
(2) $y=x+1$

Substituting in (1) value of y from (2) $\}$ $(x+5)^2+(x-5)^2=2\{x(x+1)-24\}$
$x^2+10x+25+x^2-10x+25=2\{x^2+x-24\}$
$2x^2+50=2x^2+2x-48$
$-2x=-48-50$
$2x=98$
$\therefore$ $x=49$.

$y=x+1=50$.

11. CHRISTIE JOHNSTONE.—What relation must hold good between p, q, and n, if x^n-px+q and $nx^{n-1}-p$ have a common measure?

$$nx^{n-1}-p=n\left(x^{n-1}-\frac{p}{n}\right);$$

$$x^{n-1}-\frac{p}{n}\Big)x^n-px+q\left(x-p\left(1-\frac{1}{n}\right)\right.$$
$$x^n-\frac{p}{n}x$$
$$-p\left(1-\frac{1}{n}\right)x+q$$
$$-p\left(1-\frac{1}{n}\right)x^{n-1}+\frac{p^2}{n}\left(1-\frac{1}{n}\right)$$

$\therefore$ $n-1$ must equal 1,
That is, n must equal 2;

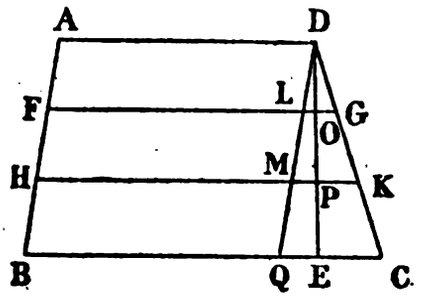
q must equal $\frac{p^2}{n}\left(1-\frac{1}{n}\right)$,
q ,, ,, $\frac{p^2(n-1)}{n^2}$,
q ,, ,, $\frac{p^2(2-1)}{2^2}$,
q ,, ,, $\frac{p^2}{4}$;

$\therefore$ They will have a common measure if $n=2$, and $q=\frac{p^2}{4}$, and the common measure will be $\left(x-\frac{p}{2}\right)$.

Mensuration.

1. TIM.—The parallel sides of a trapezoid are 14 yards and 20 yards, and the perpendicular distance is 12 yards. If two straight lines are drawn across the figure parallel to the parallel sides, and dividing each of the other sides into three equal parts, find the areas of the three parts into which the trapezoid is divided. (*Todhunter.*)

Let ABCD represent the trapezoid, and let FG, HK be drawn dividing AB, DC into three equal parts.



Also let DQ be drawn parallel to AB, and DE perpendicular to BC.

Then DQ, DE will be trisected by FG, HK.

$$LG = \tfrac{1}{3} \text{ of } QC = \tfrac{1}{3} \text{ of } (BC - AD)$$
$$= \tfrac{1}{3} \text{ of } (20 - 14) = \tfrac{1}{3} \text{ of } 6 = 2 \text{ ; } \therefore FG = 16 \text{ ;}$$
$$MK = \tfrac{2}{3} \text{ of } QC = \tfrac{2}{3} \text{ of } 6 = 4 \text{ ; } \therefore HK = 18 \text{ ;}$$
$$DO, OP, PE = \tfrac{1}{3} \text{ of } DE = \tfrac{1}{3} \text{ of } 12 = 4 \text{ ;}$$

$$\text{Area of AFGD} = \frac{AD + FG}{2} \times DO$$
$$= \frac{14 + 16}{2} \times 4$$
$$= 30 \times 2$$
$$= 60 \text{ ;}$$

$$\text{,, ,, FHKG} = \frac{FG + HK}{2} \times OP$$
$$= \frac{16 + 18}{2} \times 4$$
$$= 34 \times 2$$
$$= 68 \text{ ;}$$

$$\text{,, ,, HBCK} = \frac{HK + BC}{2} \times PE$$
$$= \frac{18 + 20}{2} \times 4$$
$$= 38 \times 2$$
$$= 76 \text{ ;}$$

Areas of the three parts = 60, 68, and 76 yards respectively.

2. M. S.—A rectangular courtyard is 100 feet long and 60 broad. Two paths cross it at right angles, one from end to end, and the other from side to side. Each of these is 5 feet wide. Find the cost of laying down the remaining area with turf, at sixpence per square yard. (*Oxford Local Examination*, 1884.)

There are four rectangular parts to be turfed, the dimensions of which are

$$\frac{100 - 5}{2} \text{ ft. and } \frac{60 - 5}{2} \text{ ft. ;}$$

$$\therefore \text{ Parts to be turfed} = \left(\frac{95}{\cancel{2}} \times \frac{55}{\cancel{2}} \times \frac{\cancel{4}}{1} \right) \text{ sq. ft.}$$
$$= 5225 \text{ sq. ft.}$$
$$\therefore \text{ Cost} = (5225 \times \tfrac{1}{6})\text{s.}$$
$$= 870\tfrac{5}{6}\text{s.}$$
$$= 870\tfrac{5}{6}\text{s.}$$
$$= £14 \text{ 10s. } 3\tfrac{1}{2}\text{d.} \quad \text{Ans.}$$

3. CARELESS. — A conic frustrum contains 3½ gallons, the diameters of the two ends being respectively 10 in. and 6 in. Suppose a gallon contains 277·274 cub. in., find the depth of the frustrum.

If a^2 and b^2 be the areas of the two ends of a conic frustrum, and h the perpendicular height,

$$\text{Volume} = \frac{h}{3}(a^2 + ab + b^2) \text{ ;}$$
$$\therefore \frac{h}{3}(a^2 + ab + b^2) = (277{\cdot}274 \times 3\tfrac{1}{2}) \text{ cub. in.}$$

$$\frac{h}{3}\left\{ (10^2 + 10 \times 6 + 6^2) \times {\cdot}7854 \right\} \text{ sq. in.} = 970{\cdot}459 \text{ cub. in.}$$
$$\frac{h}{3}\left\{ (100 + 60 + 36) \times {\cdot}7854 \right\} \text{ sq. in.} = 970{\cdot}459 \text{ cub. in.}$$
$$\frac{h}{3}(196 \times {\cdot}7854) \text{ sq. in.} = 970{\cdot}459 \text{ cub. in.}$$

$$\therefore h = \frac{138{\cdot}637}{\cancel{196} \times {\cdot}2618} \text{ in.}$$
$$= \frac{138{\cdot}637}{7{\cdot}3304} \text{ in.}$$
$$= 18{\cdot}912\ldots \text{in. ;}$$

$\therefore$ Depth of frustrum = 1 ft. 6·912...in.

4. CELT.—Find the content of a ring whose section is 9 inches square, and outside diameter 6 feet.

$$\text{Inside diameter} = 6 \text{ ft.} - (9 \text{ in.} \times 2)$$
$$= 4\tfrac{1}{2} \text{ ft. ;}$$

$$\therefore \text{ Content of ring} = [\{6^2 - (4\tfrac{1}{2})^2\} \times {\cdot}7854] \text{ sq. ft.} \times 9 \text{ in.}$$
$$= \{(6 + 4\tfrac{1}{2})(6 - 4\tfrac{1}{2}) \times {\cdot}7854 \times \tfrac{3}{4}\} \text{ cub. ft.}$$
$$= \left(\frac{21}{\cancel{2}} \times \frac{3}{4} \times \frac{{\cdot}3927}{\cancel{{\cdot}7854}} \right) \text{ cub. ft.}$$
$$= \frac{74{\cdot}2203}{8} \text{ cub. ft.}$$
$$= 9{\cdot}2775375 \text{ cub. ft.}$$
$$= 9 \text{ cub. ft. } 479{\cdot}5848 \text{ in.} \quad \text{Ans.}$$

Note.—(1) You will notice that 9 in. only instead of twice 9 in. was subtracted from 6 ft. to obtain the inner diameter. (2) 'Section 9 inches square' means that if the ring were cut, the section would be a square with side 9 inches.

5. BORDERER.—What is the height of a parallelogram whose base is 242 yards and area 3½ acres? (*P. T. Examination.*)

$$\text{Area} = \text{base} \times \text{perpendicular height ;}$$
$$\therefore 242 \text{ yds.} \times \text{perpendicular height} = 3\tfrac{1}{2} \text{ acres}$$
$$= \frac{7 \times 4840}{2} \text{ sq. yds.}$$
$$= 16940 \text{ sq. yds. ;}$$
$$\therefore \text{ Perpendicular height} = \frac{16940}{242} \text{ yds.}$$
$$= 70 \text{ yds.} \quad \text{Ans.}$$

Note.—Perhaps 90 per cent.

6. YELLSERP.—Find the area of a regular polygon of 24 sides inscribed in a circle, the radius of which is one foot. (*Todhunter.*)

$$\text{Area of polygon} = \frac{n}{2} R^2 \sin \frac{2\pi}{n},$$

where n = No. of sides, R = Radius of circumscribed circle, and 2π = 4 right angles;

$\therefore$ Area of polygon of 24 sides

$$= \left(\frac{24}{2} \times 1^2 \times \sin \frac{360^\circ}{24} \right) \text{ sq. ft.}$$
$$= (12 \times \sin 15^\circ) \text{ sq. ft.}$$
$$= \left(12 \times \frac{\sqrt{3} - 1}{2\sqrt{2}} \right) \text{ sq. ft.}$$
$$= \frac{12(\sqrt{6} - \sqrt{2})}{2 \times 2} \text{ sq. ft.}$$
$$= \{3(\sqrt{6} - \sqrt{2})\} \text{ sq. ft.}$$
$$= (\sqrt{54} - \sqrt{18}) \text{ sq. ft.}$$
$$= (7{\cdot}34846\ldots - 4{\cdot}24264\ldots) \text{ sq. ft.}$$
$$= 3{\cdot}10582\ldots \text{sq. ft.} \quad \text{Ans.}$$

7. M. R. S.—Find the dimensions of a rectangular cistern, whose base is a square and height equal to half the length of one side of the base, and which contains 53,000 gallons, each gallon being equal to 277·274 cubic inches. (*Civil Service Arithmetic.*)

$$\text{Length}^3 \times \tfrac{1}{2} \text{ Length} = (277{\cdot}274 \times 53{,}000) \text{ cub. in.}$$
$$\tfrac{1}{2} \text{ Length}^3 = 14{,}695{,}522 \text{ cub. in.,}$$
$$\text{Length}^3 = 29{,}391{,}044 \text{ cub. in.,}$$

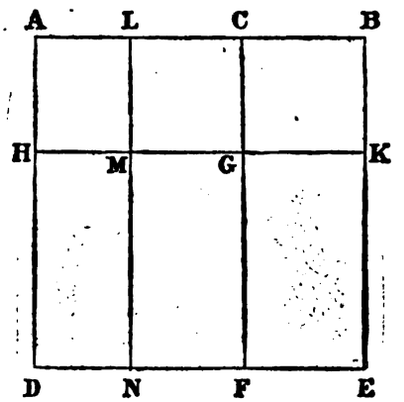
Length = $\sqrt[3]{29,391,044}$ cub. in.

$$
\begin{array}{rl|l}
 & 29'391'044(308\cdot6 & \\
 & 27 & \\
\hline
30^2\times300 = 270000 & 2391044 & \\
30\times8\times30 = 7200 & & \\
8^2 = 64 & & \\
\hline
 & 277264 & 2218112 \\
\hline
308^2\times300 = 28459200 & & 172932000 \\
308\times6\times30 = 55440 & & \\
6^2 = 36 & & \\
\hline
 & 28514676 & 171088056 \\
\hline
 & & 1843944
\end{array}
$$

∴ Length = 308·6 in.
= 25·7 ft.
Depth = 12·8 ft.

Geometry.

1. BOLDMERE.—A straight line is divided into two parts; show that if twice the rectangle of the parts is equal to the sum of the squares described on the parts, the straight line is bisected. (*Todhunter.*)



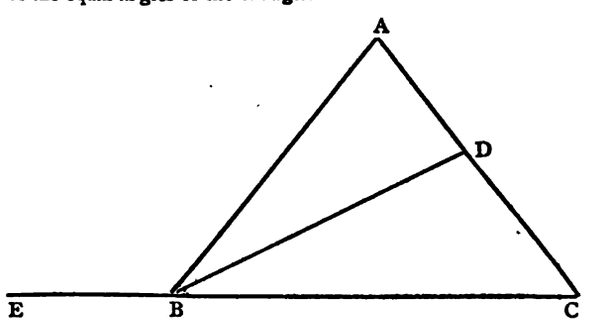
Let the straight line AB be divided into two parts at the point C, and let the squares on AC and CB be equal to twice the rectangle AC.CB; then shall AB be bisected at C.

For if AC be not equal to CB, suppose AC the greater, and construct the diagram of II. 4.

From CA cut off CL equal to CB, and through L draw a straight line parallel to AD, meeting HG at M and DE at N.

Proof.—The squares HF and CK are together equal to the rectangles AG and GE, and MF has been made equal to GE,
∴ HN and CK are equal to AG,
and LG has been made equal to CK,
∴ HN is equal to AM;
But this is impossible, for HD is greater than AH.
Hence AC and CB cannot be unequal, that is, they are equal.
Q. E. D.

2. TEMPEST.—If a line intercepted between the extremity of the base of an isosceles triangle and the opposite side (produced if necessary) be equal to a side of the triangle, the angle formed by this line and the base produced is equal to three times either of the equal angles of the triangle.



Let ABC be an isosceles triangle, and let BD be drawn equal to BA or AC, then the angle DBE shall be equal to three times the angle ABC or the angle ACB.

Proof.— ∠ DBE = ∠s ABE, ABD,
∠ ABE = ∠s BAC, ACB, (I. 32.)
and ∠ BAC or BAD = ∠ BDA, (I. 5.)
∴ ∠ DBE = ∠s BDA, ACB, ABD;
but ∠ BDA = ∠s DBC, DCB or ACB,
∴ ∠ DBE = ∠s DBC, ABD, and twice ∠ ACB;
and ∠s DBC, ABD = ∠ ABC;
∴ ∠ DBE = ∠ ABC, and twice ∠ ACB
= 3 times ∠ ABC or ∠ ACB.

Note.—If the triangle be acute-angled, the enunciation of the proposition requires some modification. Q. E. D.

General.

1. BOZ.—The solution of your query appeared in our issue for May, 1882.

2. UNITY.—(1) The solution of your query appeared in our issue for July, 1882.

(2) Yes.

3. O. H. F.—You will find the solution of your query (by arithmetic) in our issue for April, 1882.

4. TOTNESIAN.—Your query was solved in our issue for April, 1883.

5. E. H.—From the second equation the values of y are 0, and $x-3$. Substituting the former in the first equation, it becomes:—

$$x^{\frac{1}{2}} + x - 4x^{\frac{1}{2}} = 2;$$

and substituting the latter value, it is:—

$$x^2 - x^{\frac{3}{2}} - 6x + 4x^{\frac{1}{2}} = -8.$$

6. N. H. B.—(1) The deduction was solved in our issue for June, 1882. (2) It is impossible when the three given lines are parallel.

7. NIGER.—Your solution is simple and correct.

8. PROFESSOR P.—(1) You will find the solution of your query in our issue for May, 1883. (2) Perhaps 65 per cent. Your writing is not regular.

9. T. D.—The word preceding is not in the code. See 'Code,' article 57, *b* (2).

10. THEOPHILUS H. C. SHAW.—You do not state the temperature of the ice nor the coefficient of expansion of the glass used. If α be the coefficient of expansion and O° C. be the temperature of the ice, then the length will be $15(1+200\alpha)$. If L = the length at temperature t, then the length at temperature T is $L\{1+\alpha(T-t)\}$.

11. ANXIOUS.—*Mackay's* 'Geography,' *Lawson's* 'Geography,' *Green's* 'Smaller History,' or the 'Student's Hume.' These are well-known books, to be had through any bookseller.

12. BEGINNER.—Move hand and paper as you like. Dotted lines are useful at first, but should be gradually dispensed with. Try Yule's books.

13. OLIVER.—You can take 1st year's papers, but only a third-class certificate will be issued. See Code, art. 66.

14. INJURED.—(1) Yes; Code, art. 58. (2) No. (3) If you received the notice previously agreed upon there appears to be no injustice done and no cause of complaint as to that special point.

15. JEAN.—Under art. 58 of the Code it would seem that all you want is a recommendation from the elementary school in which you last served.

16. SISSY.—We have made several inquiries, but fear there is no remedy.

17. ALDYTH.—See the display of the Birmingham School Board in the Health Exhibition.

18. IXION.—Both may be correct; to decide which, one must see the context. Consult any good grammar.

19. YELLSERP.—Marks are given for one Science only; see Code, Schedule v., column 10. The remark you quote referred to the Certificate Examination, in which more marks are given for a science than for geography or history.

20. DON QUIXOTE.—Small hand is very good, with exception of the capital, which is decidedly poor. Large hand is also good, except the capitals. Value of each without the capitals 90, with the capitals 80.

21. J. P.—The resultant of any two forces P and Q acting at an angle α can always be found by the following formula :—

$R^2=P^2+Q^2+2PQ\cos\alpha$. By the terms of the question, R is twice P, and the angle α is 30 degrees. Hence

$4=1+Q^2+2Q\frac{\sqrt{3}}{2}$

$\therefore Q^2+Q\sqrt{3}=3.$

$\therefore Q^2+Q\sqrt{3}+\frac{3}{4}=\frac{15}{4}$, whence $Q=\frac{\sqrt{15}}{2}-\frac{\sqrt{3}}{2}$

$=\frac{\sqrt{3}}{2}(\sqrt{5}-1)$

$1 : \frac{\sqrt{3}}{2}(\sqrt{5}-1)$. Ans.

22. BELL.—The answer to the question is No—at least, not officially.

23. JAMES GUILD.—Small-handwriting is very good. It ought to bring 90 per cent. The large-handwriting is equally good in shape; the strokes have ragged edges, and in some cases there are evidences of painting. Use a broader-pointed pen.

24. ROMEO.—Small hand good. 85 per cent. The large hand is poor in shape throughout. 50 per cent.

25. CLARA.—The questions are published, you can most likely get them through a bookseller.

26. H.—Cemmerii were described by Homer as living beyond the ocean stream where the sun never shines. Later writers placed them either in Italy near the Avernus, or in the Tauric Chersonese.

27. ISAAC BARRETT.—The rooms were often called after the colour of the furniture and hangings, so in this case. In the second allusion, quatre of course means four; deuce-ace is a throw of two dice, one of which turns up one and the other two. Compare Shakespeare's 'Love's Labour Lost,' scene ii.

28. J. GAUKROGER.—One counts as much as the other. Finally, you will have to learn both. See reply to Resiart ap Ifan.

29. RESIART AP IFAN.—Marks are given to any candidate who has taken a first-class Elementary Stage, or passed in the Advanced Stage of *one* of eight subjects; see Code Schedule, paragraph 10.

30. WAMBRA.—The parsing of *work* depends upon the method of supplying the ellipsis. It may be supplied thus :—'I must work'—or, 'It is work.' The following is the parsing of the former :—

Work—reg. intrans. verb, act., inf., gov. by *must*.
in—prep., showing rel. between *night* and *work*.
dull—adj. of quality, qualg. *night*.
December—proper adj. of quality, qualg. *night*.
night—abs. noun, neut., sing., obj., gov. by *in*.
and—conj., cop., joining the sents. 'I must work' and 'I must work.'
work—as before.
when—adverbial conj., joining the sents. 'I must work' and 'The weather is warm.'
weather—com. noun, neut., sing., nom. to *is*.
is—irreg. intrans. verb, act., ind., pres., 3rd, sing., agreeing with its nom. *weather*.
warm—adj. of quality, qualg. weather.
and—cop. conj., joining the sents. 'The weather is warm' and 'The weather is bright.'
bright—adj. of quality, qualg. *weather*.

Your handwriting is too small and slanting for present style. It looks neat, but is difficult to read. Would get 60 to 70 per cent. of marks.

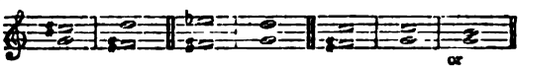
31. NEMO.—The poet by putting the statement in the form of a question, implies that there is no person who dies who wishes to be forgotten; who would allow his body to pass away from the brightness of life to the cold tomb without a fervent desire to live a little longer. Each dying person relies for sympathy upon some one, who, he hopes, will shed a tear to his memory. The last two lines assert that when life is ebbing quickly away and we are passing to dust and the tomb, the same ardent longing fills us, and the same spirit animates us as in our liveliest moments.

32. EXCELSIOR.—No. Fowle's Latin Books (Sonnenschein and Co., Paternoster Square) are excellent. Also Dr. Smith's, published by Mr. John Murray, Albemarle Street, W.

33. G. SKELLAND.—Large hand 90 per cent.; small hand, 80 per cent. Yes.

34. CÆSAR II.—The Latin Lessons will be resumed in the PRACTICAL TEACHER shortly.

35. ALBATROSS.—Solutions of your query by arithmetic and by algebra appeared in our issue for January, 1884. The answer is 18 miles.

36. WAMBRA.—

Publications Received.

Akrill (C.)—
Akrill's Arithmetical and Spelling Test Cards. Standards I. to VII.

Blackie and Son—
Algebra. Part I.

Cassell and Co., Limited—
Handbook of the New Code. By J. F. Moss.
Cassell's Modern School Test Cards. Standards I. to VII.

Chambers (W. and R.)—
Elements of Euclid. Book I. By J. S. Mackay, M.A., F.R.S.E.
Robinson Crusoe.
A Course of Arithmetic. Standards III. to VII. By T. B. Ellery, M.C.P.
Magnetism. Part I. By H. C. Tarn.

Fletcher (J. S.) and Co.—
Legs and Wings. By Theodore Wood.

Heywood (John)—
Analysis of the Book of Genesis. By Rev. T. Boston Johnstone.
Elements of Linear Perspective. By Seddon Wildeblood, F.S.Sc.
The Try Arithmetic. By Dennis Heywood.
Answers to ditto.

Hodder and Stoughton—
From Log Cabin to White House. By W. H. Thayer.
The Red House in the Suburbs. By Mrs. R. O'Reilly.
Fern Glen Farm. By Helen P. Redden.

Jarrold and Sons—
Practical Help for Infant Teachers. By J. E. Singleton.

Johnston (A.)—
Johnston's Standard Copy Books. Nos. 1 to 8, and Kindergarten Number.

Letts, Son and Co., Limited—
Letts's Illustrated Household Magazine. Part 19. September.

Longmans and Co.—
Longman's Geographical Reader—The British Islands.
Longman's Magazine. September.
A System of Logic. By John Stuart Mill.

Miscellaneous—
The Civil Service Competitor. No. 2.

Murby (T.)—
Langton's Examples in Arithmetic. Standard VI.
Algebra for Beginners. Stage I. By W. Dodds.

Relfe Bros.—
The Church Catechism. By A. Roberts, F.R.A.S., F.R.G.S. (Public Examination Scripture Manuals.)

Simpkin and Co.—
The Shilling Geography. By Dr. Morrison.

Smith, Elder and Co.—
The Cornhill Magazine. September.

Trubner and Co.—
Lessons for Deaf and Dumb Children. Parts I. and II. By W. Van Praagh.

The Practical Teacher.

A Monthly Educational Journal.

To Subscribers.—The *Practical Teacher* is published on the 25th of every month. Price 6d.; post free, 7½d.; sent post free, three months for 1s. 11d.; six months, 3s. 9d. a year, 7s. 6d.

P. O. Orders should be made payable at Chief Office.

Subscribers not receiving their copies regularly are respectfully requested to write to the Publisher.

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Accepted contributions are paid for within twenty-one days of publication.

The Editor cannot return rejected MSS.; authors should therefore retain copies.

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Portfolios, fitted with elastic bands, for preserving twelve numbers of 'The Practical Teacher,' may now be had. Price 2s. 6d. Orders should be given through booksellers.

The numbers of the *Practical Teacher* for February and March, 1884, are now out of print.

Matriculation Hints.

By Henry A. Reatchlous, M.A. (Lond.), B.Sc.,
Westminster Training College.

A very slender preparation is often thought sufficient to pass the examination in chemistry. Candidates have been known to get through who had learned all the chemistry they knew by reading a book. The chance of doing so at present is believed to be exceedingly small. It is now comparatively easy to get sound elementary instruction in chemistry. Science classes in connection with the Science and Art Department or the City Guilds are found in almost all parts of the country. The student could hardly do better than join one of these classes, and especially the classes formed for the practical study of the subject. If time is a great consideration, he might arrange to work in a laboratory for a few hours a week under the direction of a competent teacher. Of course there are cases where it is impossible to get assistance of this sort; and where, as a last resort, experiments must either be done at home or omitted altogether. Patience, ingenuity, and a small outlay will, however, make it possible to do a good deal of instructive work.

There is a pamphlet called 'Outline of Experiments suitable for illustrating elementary instruction in Chemistry' (Chapman and Hall, price 2d.). It is meant to be a guide as to the general character of instruction, and directs attention to points which should on no account be omitted. These experiments do not cover the whole course: there are none on bromine, iodine, fluorine, phosphorus, or silicon. But they serve as excellent specimens, and should all be repeated if possible.

It may be well to remind the student who is able to get the kind of instruction he wants, that he should not rest satisfied with merely preparing the compounds and examining their properties. The most distinctive feature of the present method of teaching physical science is the constant reference to weighing and measuring. This practice can hardly yet be said to have extended to chemistry. Students have been accustomed to attend courses of lectures and study the reactions of the chief elements and compounds before proceeding to quantitative work. This custom is slowly passing away. In a little book called 'Experimental Chemistry for Junior Students' (Longmans and Co.), Professor Reynolds drew attention to the importance of considering the quantities as well as the properties of the bodies under examination. This attempt was believed to be a step in the right direction. Within the last few months Professor Ramsay has published 'Experimental Proofs of Chemical Theory' (Macmillan and Co.). The professor tells us that the fundamental principles of chemistry rest on experimental proof, and it is the object of his short book to give such instruction as will enable the student to demonstrate approximately the truth of these principles. To do this it is necessary to make measurements of volume and mass, of temperature and pressure. To buy the book and read it and do no more would be to make an improper use of it; some at least of the many interesting measurements should be attempted.

The outline of experiments already mentioned will be a useful guide for the work it covers. For the sake of those who may not be in a position to judge for themselves what to pay most attention to, a few experiments on the remaining elements are appended.

Prepare a small quantity of bromine, compare its properties with those of chlorine; add sodium hydrate to bromine: sodium bromide and bromate are formed; evaporate and ignite; sodium bromide remains. Prepare HBr, either by using Br and P and water, or by passing a current of H_2S into bromine water and filtering. Volatilize a fragment of iodine, and observe

the colour, and prepare some from KI. Potassium iodide can be prepared in a similar way to sodium bromide. HI can be prepared in solution by passing H_2S into water in which I is suspended. Add chlorine water to a solution of a bromide and an iodide, and shake up with ether or benzene, notice the coloured ring at the top. Remember that HBr and HI cannot be prepared like HCl, as part of the halogen acid is decomposed by the H_2SO_4.

Powder up some CaF_2 and add concentrated H_2SO_4 and warm; the HF will etch glass. Put a little white sand and CaF_2 in a test tube, add concentrated H_2SO_4 and warm; take a glass rod and wet it; lower it in the tube and observe the frosted appearance of the drop of water at the end of it. The H_2SO_4 liberated HF from the fluoride. This has the property of dissolving the SiO_2, forming gaseous SiH_4; when this meets water it is decomposed, according to the equation $3SiH_4 + 2H_2O = 2H_2SiF_6 + SiO_2$. These changes are interesting: the deposition of SiO_2 on the glass rod is a test for the presence of a fluoride.

Phosphorus will have been used in connection with oxygen, and as a means of determining the amount of oxygen of the air. A small piece of P may be dissolved CS_2 in a test tube; if the contents be poured on a piece of paper or a duster the CS_2 will evaporate and the finely-divided P will take fire spontaneously. This and all other experiments with phosphorus need very great caution. A fragment of P can be converted into the amorphous variety by heating it in a tube containing CO_2. Notice the energy with which P_2O_5 unites with water when dropped into it. Prepare some PH_3, observing the usual cautions. When burnt in oxygen PH_3 becomes H_3PO_4. P unites with Cl, Br, and I. Add a fragment of P to a few crystals of I; the P ignites spontaneously, PI_3 is formed. Test for phosphoric acid with nitric acid and ammonium molybdate. The most interesting experiment in connection with silicon is the preparation of amorphous silica from flint or white sand. To do this, heat some white sand with six times its weight of fusion mixture on platinum foil in the blow-pipe until the CO_2 ceases to be given off. The whole should then be well soaked in water, in which it should entirely dissolve. Hydrochloric acid is added till the whole is acid to litmus paper. The solution may now be slowly evaporated; water is added to wash away the chlorides of sodium and potassium, and then the silica is dried and heated. The amorphous silica is left as a white, dazzling, and very light powder.

There is apparently with many students a great difficulty in working questions where volumes of gases are concerned. It is only rarely that one gets a correct answer to a question like this:—Twenty litres of NH_3 are decomposed, what will be the volume of the nitrogen and the hydrogen liberated? If the equations expressing the reactions are written in molecules we can take the number of molecules as volumes, and the difficulty vanishes at once; thus $20NH_3 = 10N_2 + 30H_2$—ten litres of nitrogen and thirty of hydrogen. Similarly if we want to know how many cc.'s of oxygen are required to burn completely twenty cc.'s of C_2H_4, the equation $C_2H_4 + 3O_2 = 2CO_2 + 2H_2O$ shows us that one cc. of C_2H_4 requires three of oxygen, and 20 would therefore require 60 cc.'s.

Terms like oxydizing [*i.e.*, increasing the negative element or group, as CO into CO_2, $FeCl_2$ into Fe_2Cl_6, $FeSO_4$ into $Fe_2(SO_4)_3$] and reducing should be well understood, and also the action of reducing agents like H, C, SO_2, HI, and oxydizing agents like HNO_3, Cl, $KMnO_4$, $KClO_3$.

Very excellent instruction on many points mentioned in this article will be found in the lessons on chemistry in course of publication in this magazine.

(To be continued.)

ANSWERS TO ARITHMETICAL QUESTIONS IN 'THE SCHOLAR' FOR OCTOBER, 1884.

STANDARD III.

A. 1. 823+23.
2. 945+50.
3. 1914+36.

B. 1. 4615+35.
2. 2736+43.
3. 3385+6.

C. 1. 9007+113.
2. 4867+20.
3. 5567+224.

D. 1. 110,992+1561.
2. 8470+3490.
3. 27,065+2637.

E. 1. £27 15s. 11d.
2. £347 13s. 6½d.
3. £716 3s. 3½d.

F. 1. £309 12s. 10⅔d.
2. £927 8s. 2½d.
3. £1813 8s. 9½d.

STANDARD IV.

A. 1. £193,890 6s. 11½d.
2. £94,865 8s. 0½d.
3. £162,558 0s. 9d.

B. 1. £54 1s. 0⅔d. +33.
2. £8 16s. 11⅔d. +57.
3. 2s. 2⅔d. +338.

C. 1. 551,920 drms.
2. 22,222 Eng. ells. 1 qr. 1 in.
3. 284 mls. 29 po. ½ yd.

D. 1. £141 15s. 0d.
2. £2 1s. 1d. + 220.
£187 10s.
3. £11 9s. 1d.

E. 1. £653,184.
2. £9438 13s. 0½d.
3. £138 0s. 3d.

F. 1. 2d.
2. £18 13s. 4d.
3. 476 parcels.

STANDARD V.

A. 1. £3640 17s. 8½d.
2. £58,065 11s. 3d.
3. £11,510 5s.

B. 1. £447 8s. 2⅔d. ⅝.
2. £1106 5s. 5½d.
3. £108 2s. 2½d.

C. 1. 9 lbs.
2. 41⅛⅝ lbs.
3. £168.

D. 1. $\frac{67}{100}$.
2. $\frac{11}{12}$.
3. $\frac{11}{18}$.

E. 1. £23 8s. 8⅔d.
2. £188 5s. 3½d. ⅝.
3. £4 5s. 8½d.

F. 1. 3⅝⅜ ozs.
2. £23 12s. 6d.
3. 810.

STANDARD VI.

A. 1. $8\frac{1}{100}$.
2. £1 18s.
3. $\frac{13}{18}$.

B. 1. $15\frac{7}{8}$.
2. $\frac{1}{1000}$.
3. $\frac{7}{16}$.

C. 1. $\frac{1}{17}$.
2. £47 10s. 11d.
3. (*a*) £153 6s. 4½d.; (*b*) 1200.

D. 1. 15s. 9d.
2. 52½⅛ mls.
3. 28.

E. 1. £235 4s.
2. £9 14s. 10d.
3. 84.

STANDARD VII.

A. 1. ·091125.
2. £29.
3. 512½ ac.

B. 1. £4 4s.
2. $\frac{33}{4}$.
3. £600.

C. 1. 25·6.
2. 6 p.c.
3. $3\frac{1}{16}$d. or 3·1875d.

ANSWERS TO ARITHMETICAL QUESTIONS IN THE 'LITTLE LEARNER' FOR OCTOBER, 1884.

STANDARD I.

(1) 3474
(2) 3
(3) 425
(4) 3612
(5) 609
(6) 508
(7) 3397
(8) 863

STANDARD I.—*(continued.)*

(9) 132	(25) 1218
(10) 2932	(26) 889
(11) 80	(27) 171
(12) 828	(28) 2502
(13) 3390	(29) 229
(14) 169	(30) 211
(15) 361	(31) 4218
(16) 1462	(32) 301
(17) 542	(33) 101
(18) 201	(34) 4498
(19) 3258	(35) 91
(20) 109	(36) 96
(21) 107	(37) 3680
(22) 1783	(38) 425
(23) 141	(39) 99
(24) 151	

STANDARD II.

A. 1. 178,682	E. 1. 68,920,209
2. 85,215	2. 763,899,828
3. 473,622	3. 8,393,248,640
B. 1. 17,827	F. 1. 15,780
2. 2997	2. 10,251+4
3. 20,985	3. 5733+4
C. 1. 278,194	G. 1. 8244+5
2. 447,777	2. 2864+8
3. 10,545,040	3. 1810+10
D. 1. 4,641,955	H. 1. 7561+45
2. 67,175,250	2. 756+320
3. 95,417,400	3. 7835+53

Chemistry of the Non-Metallics.

BY EDWARD AVELING, D.SC. LONDON.

[This series of articles, whilst dealing with the subjects required by the University of London for the Matriculation Examination and with those required at the Elementary Stage of the Inorganic Chemistry (Branch X.) Science and Art Department, is intended as a practical guide to the philosophical and systematic study of the non-metallics.]

EXAMPLES ON THE ELECTROLYSIS OF WATER (*For Solution*).

(27) 9 decagrams of water are electrolysed. What weight of hydrogen, what volume of oxygen are given off?

1 decagram ; 56 litres.

(28) 90 cc. water are electrolysed. What is the combined weight of the hydrogen and oxygen given off?.....90 grams.

(29) The combined volume of the two gases evolved is 5 hectolitres, 6 decalitres. What weight of water is used?

3 hectograms.

FOURTH PREPARATION. FROM STEAM AND IRON.

(1) *Laboratory Method.*—Charge a gun barrel, 3 feet in length, with iron tintacks. Fit into each end a perforated

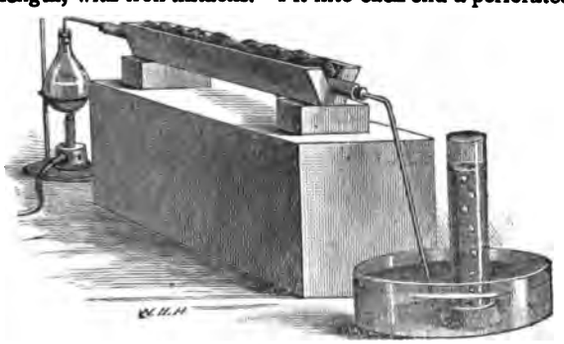

Fig. 11.

cork. Through one cork pass a delivery tube, bent at a right angle, about 6 inches from the point where it enters the cork, and again bent at an obtuse angle at a convenient place for the introduction of the free end of the tube into the opening of the bee-hive. Through the other cork pass a piece of glass tubing whose other end perforates the cork of a large flask, three parts filled with boiling water. Support the gun-barrel on a gas furnace or a charcoal furnace (Fig. 11.), and the flask on a tripod, over a Bunsen's burner. The heat from the burner drives off the water in the flask as steam. The steam passing over the red-hot iron nails, gives up its oxygen to them, while the hydrogen gas passes out by the tube, bubbles up through the water in the pneumatic trough, and is caught by displacement of the water in the gas-jars. Some of the escaping gas should also be caught by displacement of air. The compound that results from the union of the metal iron with the gas oxygen is the magnetic or black oxide of iron.

(2) *Symbols.*—$3\,Fe+4H^2O=Fe_3O_4+4\,H^2$. Fe^3O^4 may be written FeO (ferrous oxide), Fe_2O_3 (ferric oxide). The endings 'ous' and 'ic' are used in naming compounds with greater or less quantity of oxygen. This oxide is sometimes called ferroso-ferric oxide, or triferric tetroxide.

(3) *Weights and Volumes.*—The weight-number of iron =56, of H=1, of O=16. $3\,Fe=3\times56=168$. $4\,H^2O=4(H^2+O)=4(2+16)=4\times18=72$. $Fe_3O_4=3Fe+4O=3\times56+4\times16=168+64=232$. $4\,H^2=8$ by weight, and also 8 parts by volume.

$$3\,Fe+4\,H^2O=Fe^3O^4+4\,H^2$$
$$168\ +\ 72\ =\ 232\ +8$$

8 vols. (8 × 11·2 litres.)

For the last time I explain in full the meaning of the numbers given. If over 168 parts by weight (say grams) of iron, 72 parts by weight (say grams) of steam are passed, 232 grams of magnetic oxide of iron are formed, and 8 parts by weight (say grams), or 8 parts by volume (say 89·6 litres) of hydrogen are evolved. It must never be forgotten that all these calculations based upon the weight-numbers and laws of volume have reference only to the normal temperature 0°C, and the normal pressure 760 mm.

EXERCISES ON THE PREPARATION OF HYDROGEN FROM STEAM AND IRON (*Solved*).

(36) What weight of iron would be necessary for the complete decomposition of 8 grams of steam?

72 grams H^2O need 168 grams Fe.
1 gram ,, needs $\frac{168}{72}$,, ,,
8 grams ,, need $\frac{168\times8}{72}$,, = 18⅔ grams.

(37) Required 200 cc. hydrogen. What weight of steam must be passed over red-hot iron in order to obtain it?

89·6 litres = 89600 cc. H require 72 grams H^2O
1 ,, requires $\frac{72}{89600}$,, ,,
200 ,, require $\frac{72\times200}{89600}$,, = $\frac{9}{56}$ grams.

(38) The steam from 16 cc. water is passed over red-hot iron. By how much does the iron increase in weight?

16 cc. water = 16 grams, and yield 16 grams weight of steam.
72 grams H^2O cause 168 grams Fe to become 232 grams Fe_3O_4
72 ,, ,, ,, 232 − 168 = 64 grams increase of weight.
1 gram ,, causes $\frac{64}{72}$,, ,, ,,
16 grams ,, cause $\frac{64\times16}{72}$,, ,, ,,
= 14⅔ grams.

EXAMPLES ON THE FORMATION OF HYDROGEN FROM STEAM AND IRON (*for Solution*).

(30) What weight of steam must be passed over red-hot iron to yield 560 cc. hydrogen?.....$\frac{9}{10}$ gram.

(31) Steam is passed over 1 hectogram, 1 decagram, 2 grams of iron. What weight of hydrogen is evolved?.....5½ grams.

(32) The iron oxide at the end of an experiment is found to weigh 290 grams. What volume of hydrogen has been formed?

112 litres.

Fifth Preparation. From Zinc and Sodium Hydrate.

(1) *Laboratory Method.*—Place a solution of caustic soda in a flask with some zinc and apply heat, catching the hydrogen gas that is evolved by displacement of water in the gas-jars in the pneumatic trough. Sodium zincate is formed and remains in the flask. Like results follow if caustic potash is used.

(2) *Symbols.*— $2Na\,H\,O + Zn = Na_2\,Zn\,O_2 + H^2$.

(3) *Weight-Nos. and volumes.*— $2(23+1+16) + 65 = 46+65+32+2$

80 143

2 vols.

Question on the Formation of Hydrogen from Zinc and Sodium Hydrate (*Solved*).

(38*a*) If thirteen grams of zinc are heated with caustic soda, find the weight of hydrogen evolved.

With 65 grams of zinc, 2 grams H are evolved.

" 1 gram " $\frac{2}{65}$ " " "

" 13 grams " $\frac{2\times13}{65}$ " " "

$\frac{1}{2}$ gram.

Question on the Formation of Hydrogen from Zinc and Sodium Hydrate (*for Solution*).

(32*a*) What weight of potassium zincate is formed when 112 grams of caustic potash are completely decomposed by zinc?... 175 grams.

(To be continued.)

—o—

How to Teach Botany.

BY J. W. WREN,

Head-Master of the Board School, Duke Street, Deptford.

In studying the functions of leaves, the teacher would be careful to point out how the leaf agrees with the root in being able to absorb food, but, in addition to this, it is also able to assimilate it. It is a breathing organ, an organ of transpiration, circulation, and in some cases—*e.g.*, Tropœolum—of support. A section through the epidermis of a leaf placed under the microscope would show the little organs (stomates) by which transpiration is regulated. That leaves give off oxygen gas may be nicely shown by the following experiment. A few leaves soaked in water, and then laid in spring water and exposed to direct sunlight, will give off a continuous stream of oxygen, which will rise in bubbles through the water.

In the first course the scholars will have learnt the names and relative positions of the various parts of a perfect flower. In teaching the functions of the different parts, a few flower-buds will serve to show that the calyx and corolla are protective floral organs. It would be pointed out by the teacher that the rich and variegated colours of the corolla, together with the sweet odours of the flowers, serve to attract insects. The scholars will have noticed how diligently the little insects search for the honey stored up in the nectary. Whilst endeavouring to obtain this, the insect comes in contact with the anther, and the pollen is scattered over portions of its body, and, being carried away, adheres to the glutinous stigma of the next flower visited. In this way it will be shown what important agents insects are in the fertilisation of flowers.

By selecting suitable specimens, the structures and functions of stamens and pistil may be studied. After having learnt where and how the grains of pollen are produced, it will be shown that they must necessarily fertilise the ovules if the ovary and ovules are to perform their functions. A section through the ovary of some flowering plant at the time of flowering would serve to show the way in which the pollen grains which have been caught upon the stigma grow down into the ovary and penetrate the tissues of the ovule.

It will now be found to be a capital plan to exercise the scholars in describing plants. This serves two purposes, viz., it serves to fix in the memory all that has been previously taught, and to increase the interest in the study of botany. A scholar will have far less difficulty in remembering botanical terms if he be taught how to make a simple dissection and description of a plant.

The following is a good plan for describing a plant in simple language:—

Root.—Kind.
Stem.—Kind (herbaceous, shrubby, or woody).
" Shape (rounded, angular, square, ribbed, etc.).
" Direction (upright, creeping, climbing, etc.).
" Surface (smooth, hairy, rough, etc.).
Leaves.—Insertion (opposite, alternate, radical, etc.).
" Petiole (presence or absence).
" Lamina (simple or compound, venation, margin, incision, apex, general outline, smooth, hairy, etc.).
Inflorescence.—Kind of inflorescence.
Flower.—(1) Calyx (gamo or polysepalous, number of sepals, adhesion.)
" (2) Corolla (gamo or polypetalous, number, adhesion).
" (3) Stamens (cohesion, number, adhesion).
" (4) Pistil (cohesion, number of carpels, adhesion, placentation, number of ovules).

Of course any technical terms used in the above plan would have been made familiar to the scholar in some of the previous lessons.

Stage III.

The third stage is as easy to teach as the first, and quite as full of interest for the young scholar. Having already been taught the distinctive characteristics of the two great classes of flowering plants, the third stage provides for the introduction of the study of the cryptogams or acotyledons. Having already acquired some facility in observing, the comparison of flowering with the so-called flowerless plants is a subject full of interest for the young scholar. If the mature frond of a fern is allowed in autumn to wither up upon a sheet of paper in a dry place, an abundance of spores are readily obtained for experiment. A few examined microscopically will convey a correct notion as to their nature. The teacher will point out the difference between the spores of acotyledons and the seeds of flowering plants. Although the spores serve the purpose of seeds they contain no embryo or young plant. The manner of their germination may be easily demonstrated. A few being sown on some damp soil, and covered with a glass, the growth of the tiny, leaf-like expansions from each germinating spore, together with the indifferent way in which the tiny rootlets are given off from the under surface, may be easily shown. The manner in which the germinating spore gradually developes into a fern is next dealt with, so that the scholars will then have in their note-books a brief account of the life-history of a fern. The large common hair-moss serves well as a type of the moss family. Specimens being before the scholars, they will notice the difference of growth in the ferns and mosses. As some mosses bear their fruit during the winter, the

study of this part of the subject may be left until the time when the flowering plants cannot be readily procured.

The formation of the different kinds of fruits can be easily studied from specimens. Having pointed out that the fruit is really the ripened ovary, and that it usually encloses the seeds, it is advisable to study the fruits in groups. In the first group would come the nut, achene, drupe, berry, etc., being those which do not shed their seeds when ripe (indeluscent). In the second group the legume, follicle, capsule, and such fruits as shed their seeds (deluscent) would be included. After studying the mode of formation of the various kinds of fruits, they should be divided into useful and poisonous fruits, and they should be studied from this point of view. Experience shows that children may gain such a knowledge of botany, even by having only two lessons weekly for three consecutive years, as will enable them to recognise upon many an unknown plant its relation to a wholesome or dangerous natural order.

The code next provides for the study of the structure of the seed. A bean and a grain of wheat are mentioned. Providing each of the scholars with a large specimen—as, for instance, a broad bean—the teacher will proceed to examine it carefully. He will point out the scar or mark where the seed was attached to the fruit. He will point out that at one end of this there is a tiny aperture. He can show that this is so by soaking a bean in hot water for a short time, and then gently squeezing it, a drop of water is seen to escape by this aperture. Peeling the skin from off the seed, the scholars will notice the two coats. Upon laying the seed open the teacher will draw attention to each part which goes to make up the body of the seed, viz., the embryo or young plant, and the two large, fleshy lobes or cotyledons. He will point out that the mass within the coatings is entirely made up of the embryo. When studying the structure of the grain of wheat they will learn that there is in the nucleus of the seed a substance, albumen, in addition to the embryo of the plant. In addition to this, another point of difference will be pointed out. The seed of the bean contained two cotyledons, whereas the wheat grain contains only one. This causes the division of flowering plants into the two classes, dicotyledons and monocotyledons.

In studying the phenomena of germination the teacher will be greatly assisted in his explanations if he has a number of seeds in different stages of germination. He will first of all point out that certain conditions are essential to germination. They are moisture, temperature, air, and darkness.

By means of his specimens he will be able to show the whole process of germination. The seed absorbs moisture, and becomes swollen; the embryo enlarges and ruptures the integument, protrudes, and the growth of a new plant commences. The great difference between dicotyledons and monocotyledons with regard to the formation of the young root will be here pointed out. In the germinating bean it will be observed that the radicle is directly prolonged, and no branching takes place until after the root has left the seed, while in the grain of wheat it will be noticed that there is a branching within the seed, and the radicle is not directly produced.

In speaking of the changes which the seed undergoes during germination, opportunity is afforded to the teacher of imparting some elementary instruction in chemistry. He will point out that during the process of germination chemical action sets in. Some of the nitrogenous matters are changed into a substance known as diastase. This body has the power of changing starch into sugar. If the embryo plant is to grow it must receive food, but the starch by which it is surrounded is insoluble, and therefore cannot be taken in; but by the action of this diastase the starch is changed into dextrine, and then into grape sugar. The plantlet absorbs this sugar, so it lives for a time upon the nutriment contained in the body of the seed. At this stage a lesson on the malting of barley would be highly interesting and instructive, as the scholars would readily comprehend the reasons for the various processes the grain undergoes. Of course, the amount of botanical knowledge that can be gained by a scholar during his school days is not great. If, however, the directions of the code are faithfully carried out, and the teaching is intelligent and effective, a sure foundation will be laid for more advanced botanical studies. What more ennobling pastime can be found than looking on the face of nature? What greater benefit can a teacher confer upon his or her scholars than to implant in them a love of flowers? What study is more suited to lead them to admire the works of 'Him who is wonderful in counsel, and excellent in working'? Or what can give them in after life a greater pleasure than to take Longfellow's advice:—

'If thou art worn and hard beset
With sorrows that thou wouldst forget;
If thou wouldst read a lesson that will keep
Thy heart from fainting, and thy soul from sleep,
Go to the woods and hills! No tears
Dim the sweet look that nature wears.'

Professor Wilson has penned some good remarks on the value of a general knowledge of botany. He says, 'How many of our young men who visit foreign lands, bent on commercial enterprise, could tell whether the exudation from a tree was a gum, a sugar, a manna, a resin, a camphor, or a caoutchouc? whether a particular tree would yield oil or not, or fibres suitable for fabrics, rope, or paper? whether a wood was soft or hard, lasting or destructible?' No one can doubt that such knowledge may be of the utmost value in every-day life, as well as opening out to our pupils new fields of pleasure and interest whenever they ramble over the hills or along green lanes; for all true lovers of nature find 'Books in running brooks, sermons in stones, and good in everything.'

(*To be continued.*)

THE SCRIPTURE INSTRUCTION.—'I have no means of comparing the work done in other Board Schools with the results to which I have now directed attention; but from my former experience as a diocesan inspector of schools, I am in a position to say that the Scriptural instruction given at the present time in the London Board Schools is given in a very thorough and efficient manner. Dogmatic teaching is outside the limits of Board Schools, and to those who cannot conceive of religion apart from dogma, the best Scriptural teaching must always fall short of their ideal of what religious instruction should be. But those who value the study of the Bible as an important instrument of Scriptural and intellectual culture; those who think that there can be sound ethical teaching apart from religious sanctions—such persons must rejoice in the evidence as suggested by this report that some 300,000 children are at the present time being thoroughly well instructed in the London Board Schools in the elementary truths of the Christian religion.'—*The Rev. T. D. C. Morse, in the Times.*

THE DIRECTRESS OF NEEDLEWORK.

We are asked to reprint the following paragraph from the *Schoolmaster*, and the annexed reply of Mr. Hughes. The paragraph ran thus: 'H.M. Inspectors are forbidden, and we think rightly, to attach their names to any school-books. Can any one say why the same measure is not meted out to the only female official in the Department? The directress of needlework affixes her name to a series of Standard needlework manuals about to be published by Mr. Hughes, apparently as a matter of course. Impartiality would dictate a similar treatment of all the officials of the Department; but it is easy to forecast the unsatisfactory result which would spring from the same liberty being granted to H.M. Inspectors. The inference is obvious.' The following is the reply of Mr. Hughes, addressed to the editor of the paper in which the paragraph appeared:—'Pemit me to thank you most cordially for your interesting and valuable paragraph on page 327 of your last issue anent Miss Jones's "Self-Teaching Needlework Manuals" just published by me. The explanation you asked for is soon given. I had the good fortune to secure Miss Jones's able services long before she was connected with the Education Department. Upon receiving her present official appointment as the directress of needlework, I at once made it known in my advertisements; had I not done so, I am afraid that even you, sir, would have charged me with a lamentable lack of business tact. One has always a few kind Christian friends—kinsfolk, I should think, of your paragraphist—ready to set one right the moment one swerves from the path of rectitude. So the Department were apprised of the fact that Miss Jones was actually writing school-books, whereupon that lady frankly explained the nature of the engagements she had entered into with me. With a readiness which redounds to the credit of the authorities at Whitehall, they allowed Miss Jones to complete her contract in an honourable manner, at the same time prohibiting her, as is their rule, from affixing her name to any new venture. This lady, to whom you politely refer as "the only female official in the Department," has, I may add, no pecuniary interest either in the publications you have been good enough to draw attention to, or in her "Manual of Plain Needlework and Cutting-Out," which I also have the honour to publish. It is really refreshing, sir, to see the *Schoolmaster* step out of the grandmotherly rut it has so long run in, and exact fair-play and impartiality all round. I am sure you would greatly add to the interest of your journal—especially among publishers, who contribute so largely to its revenue—if you would commission the benevolent scribe who "did" the needlework paragraph to continue his philanthropic labours, and inquire into a few other cases of apparent injustice. And as charity proverbially begins at home, he might inform your readers how it is that the PRACTICAL TEACHER, and other magazines which I edit, are, though regularly sent to your office, rarely ever acknowledged, much less noticed in the review column, while a penny monthly conducted by the most prominent member of your editorial council is fulsomely praised almost every month. I have a hazy recollection, sir, that when I was a small boy, spelling my way through a certain good old book, I came across something about "beams" and "motes" in the eye. It might do your large-hearted contributor no harm to hunt up that chapter.—I am, sir, faithfully yours, JOSEPH HUGHES, Pilgrim Street, Ludgate Hill, E.C. *September 8th*, 1884.'

MODEL ANSWERS TO THE CERTIFICATE QUESTIONS, 1883.

We have unfeigned pleasure in informing our readers that we have made arrangements with Mr. Arthur Day, whose name was placed at the top of the first-class certificate list at the recent examination at the Borough Road Training College, to contribute to the November and December issues of the *Practical Teacher*

'MY CERTIFICATE ANSWERS.'

The Discipline of the Mind.

BY W. C. COUPLAND, M.A., B.SC.,

Lecturer on Mental and Moral Science at Bedford College, London.

It will be admitted that to enter into the thoughts and feelings of others is the first condition of effective social influence and real social harmony. Now this end can only be achieved by using the restricted range of feeling that falls to our own lot as a key to the inner life of other human beings. The education of the Imagination means employing the slender stock of personal experience to open up a new world of thought and feeling, in which the materials are essentially the same, but larger in amount, and of greater complexity. Without committing ourselves to the assertion that the moral consciousness is wholly dependent upon sympathy, there is no disputing the fact that a highly developed sympathy is an indispensable condition of its full unfolding. Now sympathy is the being affected by the joys and sorrows of others, as if they were our own. A low degree of it is doubtless possible as a mere consequence of unreasoning, gregarious action, but the strict parallelism between its elevation and the pitch of intellectual representation is sufficient evidence that these two are closely implicated. We are callous to others' feelings more often because we do not comprehend than because we wilfully disregard them, and the needed remedy for misdoing is often not so much the wringing of the conscience as the quickening of the Imagination.

The fact that is common to all modes of Imagination is the elaboration of a vague and formless complex conception into the definiteness of a concrete intuition. The action itself is automatic; and the function of discipline is to release the springs of activity, or to lead the mind to assume an attitude favourable for being acted upon by the unconscious spiritual forces. Music pre-eminently possesses this power of releasing the force of Imagination, owing presumably to its capacity of agitating the emotional side of mind, which after all holds the reins of Imagination.

It is here maintained that this power is both inferior and superior to the discursive operations of intellect; inferior, inasmuch as by itself it never gives us the conception of Law, and the grasp of Natural Law is the indispensable condition for correct conduct. But it is also higher than the discursive understanding, inasmuch as the re-clothing of the abstractions of knowledge in the concrete is our nearest point of contact with the Creative Power. The luxuriant imagination of Early Greek Art became in the time of Plato a reproach and a hindrance to moral progress, because the analysis of life, and not its embellishment, was required to afford principles of duty and order. But the philosophy of a Plato, though born of the inquisitive analysis of a Socrates, was assuredly the fruit of a high Imagination, which grasped a principle of moral order, which poetry had vainly striven to embody.

The application to the ordinary intelligence is not so far to seek as it might at first sight appear. It is generally recognised that the child-mind should gain its first truths through the medium of poetry and pleasing fancies. In those first years the brain is unequal to the strain of thinking by conceptions, and it needs a strong allurement to make it enter the field, often

dreary enough, of intellectual labour. Then follows the dry abstract discipline of the schools; to be again succeeded in due course by the realisation of the deeper thoughts hidden in Nature, and the attempt to frame a picture of the world and of human destiny. Knowledge, in short, begins and ends with the concrete and individual; the deeper intuition of the final stage being only possible after a certain familiarity with the unreal and abstract universal.

Here, more perhaps than in most other regions of mind, we must be prepared for great natural inequalities, as also the evil of injurious treatment may be more serious. The Imagination is a delicate instrument, easily blunted by harsh treatment, difficult to restore in good working order when grossly abused. The fruits of misdirection are mainly either a certain intellectual flabbiness and sentimentality, or a hard purblind matter-of-factness. The remedy for the former evil is to supply severer material, on which the eager fancy may be exercised, and to better purpose. To envisage geometrical relations in new aspects, to try to realize the internal movements of bodies, or to re-write thrilling chapters of history, will employ the imaginative power without enfeebling it; and on the other hand, where the ideal nature is very much below par, the sluggish imagination might usefully be jogged by reading the mind to travel with Voltaire's vivacious ancy to other worlds, where the conditions of existence, though fixed and stable enough in themselves, differ *toto cælo* from our own. The severity of truth is not maintained by a low order of the conceptive faculty, rather by the utmost freedom from the thraldom of traditional associations; so that the mind may well compound its ideas *ad libitum*, taking care, however, that its *belief* be strictly limited by the range of verifiable experience. The truth of Fact, when the eye beholds it, is ever found stranger than Fiction.

VI.—The Will and its Training.

It is usual for psychologists, when elucidating the phenomena of mind, to reserve the subject of volition for the concluding portion of their inquiry. This general practice has perhaps given occasion to the belief, as it has not unfrequently been dictated by it, that we have in Will a faculty superposed on the other mental powers, a faculty even of a higher and quite special character. It should, however, be made clear that the only legitimate ground for the postponement of the topic of volition is one of convenience; that no question of principle is involved in such an arrangement; and that to introduce the question of *worth* is to import considerations alien to the scope of Psychology, as a Natural History of Mind. So injurious, however, has been the effect of this uniform practice, that I am not sure that a psychologist would not be rendering a valuable service to science who should break through this long-established custom, and *commence* his exposition with a thorough analysis of our voluntary activity. For indeed I hold it to be plain that will, or something akin to it, is inseparable from mind, and irresolvable into simpler elements. To feel, to think, and to will, are but different aspects of one conscious life. We cannot feel without distinguishing this present impression from its forerunner, without noting points of agreement and difference with a cluster of remembered antecedents, *i.e.*, feeling is implicated with knowing, and feeling that should have no motive power is equally inconceivable; in other words, feeling, thinking, and willing are mutually involved.

Two errors must be signalized here in familiar theories of the Will. The one is, that we have in human volition something which has no prototype in animal will in general; the other that volition is derived from faculties yet more elementary, that it is the result of intellectual laws of association operating on random manifestations of mere animal life. I think there is good reason for denying both these suppositions. To take the last first. What coherent account can be rendered of the process indicated? It looks almost like a reflection of the old creation-hypothesis, the venerable notion that a Cosmos emerged from pre-existing Chaos, that by some mysterious magic a plenum of order was conjured out of a void of disorder. If there was no germ of order in the apparent disorder how could the world-order ever have been manifested? So in this theory of the will, which requires a straining towards an end as the offspring of an aimless spontaneity, what sort of thing must that spontaneity be which has no principle of determination at its core?

But we certainly do not get much more light when we are informed that human will is *sui generis*, that the actions of lower animals are phenomena of reflex action and instinct, are the manifestations, that is, of a physical mechanism, consciousness being either wholly absent or merely concomitant, the animal being a passive instrument used by an extraneous force. Whence came this novel faculty that has no forerunner in the world of lower organization? And what is the proof that there is this gulf between the minds of brute and man? Not only is there no proof, but all the evidence tends the other way. Comparison of the ways of animals with the ways of men shows that all the psychical functions exhibited by man are present in the animal world, though in simpler form, even at the lowest level of animal existence. And careful criticism also pronounces the wit of man unequal to unravelling the last skein of consciousness, and while acknowledging the ingenuity which essays to display the components of complex modes of will, leaves the Will's own essence as an ultimate fact, coeval with the origin of mental life itself.

The task left to the psychologist, then, is to show how, given the ability to relate and react upon impressions, the thoughts and emotions which make up the content of consciousness, are slowly elaborated; and given a selective power, how the organism can turn this material to account for the furtherance of its own and others' well-being.

The forces impelling to voluntary action are called motives; wherever no motive is discernible or conceivable we refuse to characterise the action as voluntary. A true motive is a feeling with a pleasurable or painful quality. The law of the will is said to be the preference of what the individual mind takes to be maximum pleasure, aversion to what is regarded as maximum pain. The case is rarely so simple as that a single motive, a single pleasure or pain, that is, is present to the mind. Usually there are several such pleasures and pains competing for influence, and hence the act will frequently be no index to the amount of mental work which has been previously gone through. It may even happen that the resultant of these forces is total inactivity, in which case the anticipated

pleasure must have been balanced by the idea of sequent pains. In such a case this alternative presentment of pleasing and painful pictures appears in consciousness as a conflict of opposing powers, and the adoption of the course actually taken is described as an act of *choice*. Now, when the forces have been few or all in the same direction, or there is no impediment to action, attention is not called to the fact of a personal reaction on the feelings. It is only where the resistance encountered is considerable, where there has been much 'deliberation,' and consequent 'resolution,' that the circumstance is noted that we take part in the proceedings as persons, and hence effort comes to be considered a characteristic mark of will. But the difference in the two cases is not one of degree, but only of kind. What difference can it make in principle whether the effort is so slight as to be evanescent, or whether the antagonistic forces are so numerous as to give rise to a considerable sense of struggle? The complication of the motives can have nothing to do with the question whether the action be voluntary or involuntary. An action is voluntary when our spiritual nature reacts upon the feelings which, either in fact or in idea, affect the mind. We must take care, however, not to be the slaves of our own instrument, language. The person which embodies the willing power, as we term it, is the formed character of the man—that evolved spiritual organism which is substantially transmitted, which is only so mysterious in its mode of operation because it embodies the tendencies of countless generations of active intelligence. To predict the probable conduct, it is necessary that we have not only a full knowledge of the motives actually present, but large acquaintance with the character; for the conduct will always be the resultant of these two conditions. It is not to be expected that our inferences will be correct when we ignore either factor, least of all when, as is frequently done, we look only at the motive and disregard the sort of mind brought under its influence.

(*To be continued.*)

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Publications Reviewed.

The Elements of Euclid. Books I. to VI., with Deductions, Appendices, and Historical Notes. By John Sturgeon Mackay, M.A., F.R.S.E. W. and R. Chambers.

This work has been compiled at the request of the above well-known firm of educational publishers, and will, no doubt, no less on account of its manner and cheapness of production, than of its intrinsic merits, as a text-book of Euclid's method of geometry, demand a large sale.

The author tells us in his preface that he has not adhered uniformly to Dr. Simpson's editions; and we venture to fear that in the second book, by changing the wording of the enunciations of some of the propositions, he has gone almost too far. In these days of examinations—and long may Euclid, as such, find a prominent place in examinations—those text-books will be used most which assist students the best for examination.

We very much doubt whether the average schoolboy, who is being examined in the first two or three books of Euclid, will realise that he has learnt the proposition given to him in the form of—'If a straight line be divided into any two parts, four times the rectangle contained by the whole line and one of the parts, together with the square on the other part, is equivalent to the square of the straight line, which is made up of the whole and that part,' because he has learnt the following: 'The square on the sum of two lines, diminished by the square on their difference, is equal to four times the rectangle contained by the two straight lines.' Yet such is the new enunciation of the old eighth of Book II. In this proposition the editor has omitted the diagonal, retaining it, however, in the other cases where it is found in Simpson.

Other propositions in this book are altered in form by the introduction of the idea of an external section of a line, and what Euclid calls the part produced becomes a segment. This is done, of course, with the idea of coupling together such propositions as the fourth and seventh, or ninth and tenth, but he does not dare to introduce the idea of a line measured in the opposite direction to another line as having a contrary sign, so as to prove such pairs of propositions simultaneously.

In the third book, reflex and straight angles are used in the proofs of two very important propositions without any very great advantage. At the same time we must admit that Euclid acknowledged the possibility of such angles appearing in certain cases, *e.g.*, when he takes any equi-multiples of arcs in vi. 33., he makes no limitation as to the size of the angle the resulting arc would subtend.

The fifth book we are glad to see retained in a geometrical form; for though the lines (one can scarcely call them figures) are omitted, the subject referred to therein is treated in almost exactly the same way as we find it in Dr. Simpson.

At the end of every proposition there are from seven to even fifty questions and riders, and at the end of each book, except the fifth, besides an appendix, there are miscellaneous deductions, depending on the principles proved in the book.

These appendices are very valuable, and deserve careful attention. In them we find, discussed and carefully explained, such new terms, to a schoolboy at least, as 'median of a triangle,' 'orthocentre,' 'centroid,' 'potency of a point,' 'radical axis,' 'harmonic conjugates,' etc., etc. The well-known facts as to the concurrency of certain lines, or that certain points are in the same straight line, are proved in the appendix to Book I. In that to the fourth book we find the interesting properties of the 'nine point circle' discussed, whereas in that to the sixth book the difficult subject of transversals is introduced. Questions on Loci are also given at the end of the books.

Symbols are used freely, even to the objectionable + and −, but the latter is, as we have said above, only used as a sign of subtraction. In one place the author warns examinees that they must not use some of his symbols in England; but is it wise to introduce them in a text-book for students if they are inadmissible in any examination? These defects, if defects they be, are, however, a hundredfold counterbalanced by the thoroughness of the work and the multitude of well-arranged questions and deductions; and we feel convinced that no teacher could take his classes carefully through the work from one end to the other, getting all the questions answered and deductions worked out, without giving them an extraordinary grounding in geometrical reasoning of incalculable advantage to his pupils, whether intending to pursue their mathematical studies any further or not.

The Elements of Euclid. Book I., with Deductions, etc. By J. S. Mackay, M.A.

This is the first third of the above, bound separately for the use of the lower classes. It includes the appendix and deductions to Book I.

Blackie's School Classics. Merchant of Venice. Blackie and Son.

This is a small volume of 104 pp., being one of a series of English School Classics, called into being by the recent changes in the Education Code.

As an appendix to the text (Globe Edition), the editor has conceived the happy idea of giving Lamb's 'story,' which is called a prose edition of the play. The text is preceded by a very short sketch of the dramatist's life and writings, and succeeded by some twenty pages of notes of a very simple, but, to a child, useful character. We heartily commend the edition to others than, as well as, managers of Board and national schools, as a useful and cheap manual.

The Art of Solving Problems in Higher Arithmetic. By the Rev. J. Hunter, M.A. Longmans, Green and Co.

Not very long ago we had the pleasure of drawing our readers' attention to a valuable little work of this author, called Supplementary Arithmetic. This volume may almost be said to be supplementary to that.

No one can peruse carefully the lately set examination papers in this science, without feeling that there are questions in them which do not come under any special rule or rules, as generally given in modern arithmetics. It is to try to show the principle on which such questions are set and may be solved that Mr. Hunter devotes himself.

He says, and rightly, that many of these problems are suggested to an examiner by having an entire arithmetical statement before him, result and all. In an arithmetical statement any term whatever can be chosen as the thing sought, but with very different results as to the difficulty in finding it; *e.g.*, it would be very easy to prove that $(3\times6-8)\ 4=40$ if 40 be the term asked for; but by no means so easy to find the 3, or the 6, or the 8, or even the 4.

Many people would be astonished to find how the majority of children would puzzle over such a question as would result, if the 3 (say) were asked for to complete this statement. The question might run something like this, 'What number, after being multiplied by 6, and then diminished by 8, and this difference multiplied by 4, would give a result of 40?' To take an example of which Mr. Hunter treats. It is not very difficult to find out the difference between two incomes derivable from two investments in certain stocks of the same or different amounts of money; but let this difference be known and one of the elements on which it depends be the thing sought, and the question becomes very often intensely difficult.

The matter of 'unit,' though often introduced into the working of certain questions, is not treated of as a principle—as it might have been. Questions, too, on the interchange of the monies of different countries are entirely omitted, though useful as an intellectual exercise. Unequal divisions, whether the inequality be one of difference or of ratio, are well discussed.

In one or two of the examples, symbols are employed for an unknown quantity, and treated as numbers. Now this, we maintain, is not arithmetic. Whether the following question can be worked by pure arithmetic we will leave to others to decide, but certainly Mr. Hunter has not solved it so:—

'I invested £3,640 in the 4½ per cents., and on the price falling ½ per cent. I transferred the whole to a 6 per cent. stock at 92, and thereby augmented my income by £78 15s. At what price did I buy into the 4½ per cents.?' Mr. Hunter begins by writing N. for the number of cents. bought at first, and treats this N. as if it were known, until we come at last to 139 N.=4865, and so obtains the result.

There is a chapter on Latitude and Longitude, as to the distance between two places on the same parallel of latitude, and the difference of time at places of different longitude, but it is not very valuable, as neither calling forth much thought on the one hand, nor obtaining perfectly accurate results on the other.

Clock problems are coupled with those on racing on circular courses, and give rise to some interesting but not very difficult problems.

The book will be found eminently useful to tutors preparing men for examinations, being well provided with examples. Those not knowing the Author's compromise between the unit and the old method of working questions in proportion, ought to peruse his book on the subject.

Little Children's Hymns and Songs. Hodder and Stoughton.

The compiler of this pretty little volume tells us, in the preface, that the hymns and songs have been chosen as suitable for children to use as children, and only contain thoughts and facts which their little minds can grasp and understand. It is, doubtless, almost painful to hear a band of healthy choristers sing many of the words we find in the Church hymn-books, such as express a longing to leave this world, etc., and it is well in collecting or writing hymns for children not to put words into their mouths that they do not, nay, cannot feel. Some years ago, we remember rather a rage for the biographies of precocious children, in which we read of babies of four longing to die, etc., etc.; but the good taste of the public seems now to have driven away such publications altogether. No doubt familiarity with unsuitable hymns had a good deal to do with these unnatural expressions.

In the index we find such well-known names as J. Keble, H. K. Lewis, Dr. Faber, F. R. Havergal, Jane Taylor, etc.; and George Macdonald's wonderful 'Baby Theodora,' though extracted from a fairy story, is here too, as it ought to be in every collection made for children. That queen of baby song writers, Mrs. Alexander, is also represented, but not in one of her happiest efforts. Many of the songs, we are told, can be obtained set to music in a separate volume.

Murby's Scripture Manuals—Judges. London: Thomas Murby.

We have here a revised and enlarged edition of this particular number of the above manuals. After a short introduction we find two summaries, entitled respectively 'brief' and 'complete.' These are followed by biographical and topographical notes, arranged in alphabetical order, concluding with some short and instructive notes on the text. The little work does not seem likely to replace the story in its Biblical form, which so many of these helps to Bible knowledge seem to aim at. We therefore heartily recommend it. We are glad to see the English equivalents of the Hebrew names given in the biographical notices.

Industrial Curiosities. By Alexander Hay Japp, LL.D. London: T. Fisher Unwin, 26, Paternoster Square.

This is a reprint of a number of papers on Curiosities of the Industrial World contributed by Mr. Japp to various magazines and periodicals. Some idea of the favour with which the public have received the book may be obtained by the fact that this is the third edition. The book is well written, the papers are very interesting, and as varied as they are interesting, ranging from a visit to Chatham and the manufacture of 'locks and safes' at Wolverhampton, to the curiosities of the 'Post Office,' the mysteries of 'Through Traffic,' 'In a Hop Garden,' and other equally curious subjects. We think the literary matter worthy of better illustrations, and that the opportunity might have been taken to bring the information connected with the Post Office down to a later date, some of the reforms advocated having been already adopted. The book will fill a useful place in a school library, and teachers can find material in it for a score of capital object lessons.

A Complete Latin-English and English-Latin Dictionary. By John T. White, D.D., Oxon. Longmans, Green and Co.

This work requires more than the passing notice of a later edition of a well known and justly-valued publication. In the preface, the author tells us he has intro-

duced a peculiarity which he believes to be a novelty in lexicographical works. This peculiarity consists in the introduction of hyphens, to separate the different parts of the words.

When the simple words appear in the compound word in their original form, the hyphens are introduced into the leading word itself, without any remark thereon, but if only the root or a changed form of the simple elements be found in the word, then the elements in their entire form are given afterwards, and the connecting vowels or euphonic consonants are shown by being placed between brackets thus: 'aur-i-fer' is followed by this explanation [aurum-(i)-fero]. In all cases the suffix is carefully separated from the root or stem, but if the suffix be connected by means of a vowel or euphonic consonant, the connecting vowel or consonant is not separated from it, as the 'i' is in 'aurifer': thus:—monstrum is printed mon-strum, and no etymological explanation is given of the 's.' The word 'rostrum' is thus printed: [for rod-trum fr. rodo]. Surely 'rostrum' is written for 'rod-s-trum,' the 'd' being omitted for euphony's sake before the 's,' as in the case of the sigmated tenses of lingual verbs. It is to be hoped that teachers, whose pupils use this dictionary, will study the preface carefully themselves, and then insist upon their pupils examining these etymological facts, so as to give the formation, etc., of each word. We don't suppose one boy in ten, nay, not one in a hundred, ever read the preface to his dictionary, any more than one out of a thousand, who uses the Book of Common Prayer, has read its preface; but we strongly recommend all teachers and those teaching themselves to carefully study this preface before they use the book.

The English into Latin is not much more than half of the length of the first part; but contains most that a student could require for writing Latin, prose or verse.

The book is clearly printed on good paper, and very cheap. We have no doubt it will hold its own place in the hundreds of schools where it is, at present, regularly supplied to those who have no other Latin dictionary.

Public Examination Scripture Manuals. By Arthur Riches, F.R.A.S. The 'Church Catechism.' Relfe Brothers.

This is a set of questions, carefully answered, on the Church Catechism. The sections are well made, and each section carefully redivided. The Scripture proofs are referred to at first, and printed *in extenso* in a subsequent division, the wisdom of which we doubt. At the end of each section there is a subdivision entitled 'Names,' in which some of the names or expressions used in the section are explained—*e.g.*, Beelzebub, Lord of Flies (the chief deity of the Ekronites); Superstition, belief without good evidence.

The 'Duty towards God,' 'towards our neighbour,' and 'The desire' are printed side by side with the Commandments and Lord's Prayer, showing at a glance the commandment or petition referred to in each portion of the 'duties' or 'desire' respectively.

One of the subdivisions of each of the Commandments is headed 'Broken by.' This gives two or three Scripture examples; and in the case of the First and Second Commandments we are sorry to see the following addition: 'And the Romish Church, who,' etc., etc. We are all the more astonished at this, as in the answers on the Sacraments, the author answers two questions, where he might have vilified the Church of Rome, by giving quotations from Hooker. The manual is well printed and very cheap.

A System of Logic, Ratiocinative and Inductive. By John Stuart Mill. London: Longmans, Green and Co.

This is called a 'people's edition,' and consists of the above well-known work, printed—and well printed—on 600 odd pages in double columns, and thus rendered suitable in price for 'the people.' We heartily recommend it to those who have been debarred previously by the expense of the work from obtaining and studying it. We fully expect that the many modern geometries constantly emanating from the press will tend to bring back logic as an examination subject. The study of Euclid was thought to be an efficient substitute for that of logic, and Dr. Simpson's edition of Euclid was, no doubt, an excellent course of ratiocination; but now, when the celebrated 'pons' is supposed to be proved in two lines, though geometry may be taught more quickly, the mind is not trained, as it is by Euclid's longer and more rigid reasoning, and we shall have to have recourse to logic as our great educator.

Elementary Mechanics. By W. J. Harrison, F.G.S. T. Nelson and Sons, Paternoster Row.

This little volume, like all the school-books issued by Messrs. Nelson, is thoroughly well got up. The paper, printing, illustrations, and binding leave nothing to be desired. The book is divided into twenty chapters of six to seven pages each, which are to be regarded as first lessons in Natural Philosophy. It must be remembered that the author of a book of this sort is often not at liberty to do as he likes either in the selection of the matter, or the mode of presenting it. A syllabus has often been drawn up for him, and he adapts his materials to its requirements. Mr. Harrison has given us some very useful information expressed in clear and simple language. There are a few suitable questions on each chapter at the end of the book. It is said that mechanics, as it is called, is a difficult subject to teach. And it may well be. Until scientific men will agree to attach precise meanings to words, good teaching must necessarily be difficult. Take the word force. A boy reads that force is that which changes, or tends to change, the motion of a body. Then he comes to the force of cohesion, of sound, of light, of heat, and finishes up with vital force and centrifugal force. Possibly he may hear of the correlation of the forces, and even the storage of force. Finally, he will be told that force is a rate and nothing else. Could anything be more distressing? Will the Committee on Electrical Units extend their labours and settle a few leading terms, and give us names for the units of velocity, acceleration, and momentum, etc.? This is work imperatively needed, and work which can only be done by the most eminent men of the day.

Chemical Tables for Elementary Students. Adapted to the new Syllabus of the Science and Art Department. By Wm. Noel Kemp, F.C.S. London: Simpkin, Marshall and Co.

This little manual is intended for the use of pupils studying for the Practical Inorganic Examination of the Science and Art Department. The idea of studying science for the purpose of passing an examination is apt to be ridiculed just now. It is the fashion to decry small manuals prepared for such a purpose. And, doubtless, many of them do more harm than good. Public attention is now being powerfully directed toward a study of things themselves instead of the study of what other people say about them. It is quite true that we cannot learn botany or chemistry by reading books or attending lectures. The pupil must see and handle the things for himself. But how many will do this effectively without proper direction? If an ample supply of natural objects were all that is necessary, none of us could complain for want of them. We are all surrounded by things about which many of us remain ignorant the greater part of our lives. Any book, however humble, which leads people to examine things for themselves, and gain a really useful knowledge of them, should be accepted thankfully. The elements of chemical analysis can be taught without the use of any text-book at all, but such a method has many drawbacks. The little work before us is clearly drawn up and well printed. A boy who works through it is not likely to find any difficulty in the practical examination of the elementary stage. We think the book would have been greatly improved by the addition of a few pages of exercises. Boys will not compare the actions of reagents upon different compounds unless they are obliged to do so.

Macaulay's Milton. Edited to illustrate the Laws of Rhetoric and Composition. By Alexander Mackie, M.A. London: Longmans, Green and Co.

This little volume is a relief after the two just reviewed, and is intrinsically, all comparisons apart, an agreeable surprise. Not that Macaulay is, nor even was in his own estimation, quite as great a writer even for the young as Shakespeare. It is Mr. Mackie's method of dealing with the essay on Milton that has the charm of freshness. Very justly he protests, as we have done in reviewing the two Shakespeare plays, against the mere discussion of archaic words and information of a geographical and historical nature. The chief value of a classic is for style, a point to which our Clarendon Press editors and all the crew of small editors that struggle in their wake, pay absolutely no attention. We hope we are not prejudiced in favour of Mr. Mackie, because he endorses views that we had expressed, curiously enough, just before taking for review this work. Macaulay's works combine information with an interesting and, in some respects, an admirable style. As to the information and criticism in the essay under discussion, the former is not very noteworthy, and the latter not very trustworthy. But as a study, active and passive (if we may so say), of literary style, the essay is very useful. As to Macaulay's writing, it is instructive in every way, and not least in the Helot fashion. There is so much in it that should be a warning to the young writer as to how not to do it. Yet Mr. Mackie, with all his righteous protestations, makes the inevitable concession to custom. He gives a series of notes and memoirs of Milton and Macaulay. Despite the concessions, the book is a very good and a very useful one. Beginners, and even those who fondly imagine themselves past masters in composition, can learn the names for all sorts of literary combinations that they have read or even used unconsciously in ignorance, more or less blissful of the nomenclature of the literary art. Epigram, inversion, parallel, construction, metaphor, explicit reference, balance antithesis, together with such barbarisms as synecdoche and antonomasia, are all explained and illustrated. For those who want to know the dry bones of composition, the work of Mr. Mackie will be most useful. They will, of course, keep in mind that the knowledge of these is no more equivalent to writing well, than a skeleton is to a human being.

Chambers' Geographical Readers. Standards III. and IV. London and Edinburgh: W. and R. Chambers.

These books, while avoiding unnecessary multiplication of names, omit no important geographical fact. They are *reading-books*, and not simply text-books on geography. The illustrations are suitable, the maps clear and plentiful, and the lists of words full and carefully selected. Revision lessons are added to each book, and increase the usefulness of the volumes.

From Log-Cabin to White House. By W. M. Thayer. London: Hodder and Stoughton.

When a biography has reached its twenty-third edition, there is but little left for the critic to do. We therefore simply announce that the edition before us is one of rare beauty. This interesting story of President Garfield's life, enriched as it is with twenty superb woodcuts and two steel portraits, and clad in an exquisite binding, cannot fail to form one of the most coveted gift-books of the coming season. It has our heartiest commendation.

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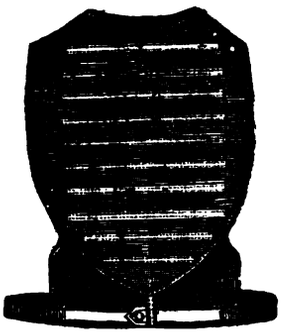

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Hygiene.

BY ALFRED CARPENTER, M.D., M.R.C.P. (LOND.),
Chairman of the Council of the Sanitary Institute.

NATURAL VENTILATION—(*continued*).

THE inlets for fresh air must correspond with the size of the room, the uses to which it is to be put, the number of living occupants, and the character of the warming and lighting which is to be in use. The total area of the exits for the used-up air must be quite as large in superficial area as the inlets, and if possible, somewhat larger, so as to correspond with the increased dimensions of the warmed air. The outlets should be more numerous than the inlets; a superficial square foot may be calculated as sufficient outlet for the used-up air of five or six persons or for nine children. It is usual, however, to have the inlets more numerous than the outlets; they should be smaller than the outlets, so as to distribute the admission of fresh air and avoid draught. The inlets must be protected from the influence of the wind, or be so arranged as to be capable of opening on the opposite side of the room to that from which the wind is blowing. Care must be taken that the outlets are not exposed to the force of the wind, otherwise the current is changed, the outlets become inlets, and cold air comes in at the wrong place. It is very important that this possible change be provided for. A large room which is to be used by a few persons only will not require so much ventilating area as one which has occasionally to be crowded with a large audience, such as a concert or assembly room. Again, it must be borne in mind that persons sitting in quiet repose produce much less impurity than persons actively employed. A person asleep evolves less than half a cubic foot of CO_2 in the hour, or 0·5; sitting quietly in his chair it amounts to 0·76; whilst actively employed the amount excreted equals 1·50 per hour. Approximately, we may assume that the figures 2, 3, 5, and 6, will be about the proportions of fresh air which are required, according as the person is asleep, in quiet repose, at gentle work, or working hard. There is another calculation which is based upon the weight of the person for whom the air is required; it is not a sound basis. We must not forget that tissue-change is greater in children and young people than in adults and in the aged. It may be calculated that the quantity of CO_2 excreted per hour in a mixed assembly will be from 0·6 to 0·7 of a cubic foot per person. The quantity of CO_2 produced will be also a measure of the kind of organic impurity, which is most easily detected by the smell. Ventilation which does not take away the evidence afforded by the nose, and which is usually styled 'closeness,' is not a sufficient ventilation. The amount of CO_2 must not be allowed to double the ordinary quantity, for when it passes beyond four parts in 10,000 it is in excess; and if it reaches six or seven parts, the organic matter becomes very perceptible to the senses. Keeping these facts in view we have a guide as to the quantity of fresh air which ought to be admitted every hour. The larger the quantity of CO_2 present in the external air the greater must be the quantity admitted by ventilation. The amount of cubic feet of air or breathing-space per individual, as far as the admission of fresh air is concerned, is not an important factor, as compared with the necessity for air to be admitted into a crowded assembly which is already impure; but if the arrangements are provided in accord with the number of people present, the quantity of air, per hour per person, remains the same. If it is necessary to keep the air perfectly pure, 3,000 cubic feet must be admitted every hour for every person. That quantity will keep CO_2 at or near its normal. The cubic space within is of no importance; but the quantity of air admitted for an adult male should be about one cubic foot per second, to secure perfect purity. If the adults are hard at work—as when engaged in workshops or mines—the quantity admitted must be increased. It has been urged that if it is necessary to keep up the greatest working power of those employed, not less then 100 cubic feet per minute per man should be introduced; but this is far more than that which is usually provided. It must be increased or may be lessened according to the quantity required for fires and lighting, or for the use of animals employed within the area provided for. As regards animals, perhaps the best arrangement will be one which is based upon the weight of the creature. It should be at least a cubic foot per hour for every pound in weight; some writers insist upon one and a half cubic feet. The smaller the animal the greater the quantity of air required. A horse or a cow requires from 10,000 to 18,000 cubic feet per hour.

It is also necessary to make arrangements to get rid of the products of combustion, especially when gas is used for lighting purposes. A cubic foot of gas produces two cubic feet of CO_2. A common burner, producing a flame equal to that in any ordinary street lamp, consumes five feet of gas per hour. Suppose the burner to be alight four or five hours on an average per evening, there are at least forty cubic feet of CO_2 to be removed, and for each cubic foot of gas consumed about 1800 cubic feet of air must be introduced. A common fish-tail or bat's-wing burner requires that from 60 to 70,000 cubic feet of fresh air be introduced to keep down the CO_2 to a normal standard. It is not necessary to provide anything like the same amount of fresh air when ordinary candles are used; neither is the presence of CO_2 which has been produced by lighting arrangements so dangerous as that which is caused by living creatures, for the organic matter detected by the nose is not produced. The apartments which are occupied by sick persons require double the quantity of fresh air to that which is required for those in health.

Cubic Space.—I have said that the principle of ventilation is of greater importance than the simple question of cubic space, but certain arrangements are based upon this question, and it is right to mention the requirements of authorities upon this point. It may be argued that the larger the air space, the less the necessity for frequent removal, and if the rush of air is diminished, so also are the chances of draught. A small room occupied by a certain number of persons will require to have its air changed five times as frequently as a room which is five times larger, but only occupied by the same number of people. Notwithstanding this, authorities insist upon a certain amount of floor space, or of cubic contents, which, however, is far below the absolute requirements for health, as will be at once seen if we compare the measurements required by law with what is stated above:—

In barracks a man is allowed	600	cubic	feet.
In wooden huts (in the army)	400	,,	,,
In hospital wards	1,200	,,	,,
In fever wards	3,000	,,	,,
In common lodging-houses from 240 to ...	300	,,	,,
In workhouse dormitories	300	,,	,,
In school-board schools (9 sq. ft. floor space)	80 to 110	,,	,,

But all questions as to floor space occupied by children at school, or cubic space in dormitories, are altogether secondary to the principle of ventilation. If we ventilate a room well, it will accommodate double the number of persons, whilst a badly-ventilated apartment will smell and be unwholesome if only half the number allowed by authority are present in it. Cubic space cannot and must not be allowed to take the place of a frequent change of air.

The cubic space required for animals is capable of perfect regulation, because the animals do not exert their own will, or shut up the ventilators as human beings do. Horses and cattle should have a floor space of from 80 to 120 square feet, and a cubic space of 1,000 to 1,800 feet. The usual allowance in cow-sheds is seldom more than 800, and many of the metropolitan sheds have less than 600 cubic feet per animal. In the army each horse has, according to the army regulations, 100 square feet of floor space, and 1,605 feet of cubic space. In the Horse Infirmary the allowance is 137 feet floor space, and 1,900 cubic space.

Artificial Ventilation is brought about by two different ways. The 'vis a tergo' and the 'vis a fronte.' Air is either driven in, which is called the method of *propulsion*, or it is drawn out, which is styled the method of *extraction*.

Ventilation by propulsion is carried out by means of fans or bellows, or the punkah. It is a certain method, the current can be forced into any place, and the air can be washed in its course. The greatest objection to its use is its cost, and the certainty, sooner or later, of the machine breaking down, usually when most wanted. Ventilation by extraction is also effected by a fan or screw, which draws out the air just as a pump lifts up water, or it is acted upon by a steam jet, by which it is forced into movement in an upward direction, or it is forced into a current by heat. Of these plans the last is the most common. The chimney shaft effects a change of air by the current which it promotes even when the fire is not burning. If the fire is burning it will be in proportion to the size of the fire and the diameter of the chimney. The current is usually from 3 to 6 feet per second. If there is a large fire it will be doubled, and in a furnace fire it is greater still. Those places which were provided as outlets for air, under these circumstances become inlets if the arrangements for the admission of air do not allow of a sufficient supply through the ordinary inlets. If there are not sufficient inlets provided in the ordinary sitting-room, air is brought down from the top of the chimney, and the fire-place puffs out smoke into the room. This is the cause which produces smoky chimneys in a great number of instances. Such may be at once cured by providing a proper supply of air. The main use of a chimney for ventilating an apartment is the constant upward current which the fire produces. The fire not only consumes the oxygen, but the chimney acts as an exhauster for the room, by taking up a quantity of air which has not been burnt. The change from the large open chimneys to those now in fashion, in which only air which has been consumed by the fire is used, has led to a large diminution in the ventilating power of chimneys, and diminished the healthiness of the living rooms of the wealthy. It is an instance of the way in which so-called civilization and the study of the beautiful is cultivated at the expense of health. The principle of extraction is also used when gas jets are burned in shafts which are provided as outlets, and when it is necessary to establish a current upwards, a combination of gas jets with shafts, so arranged, that the heated air passes out into the open without entering the apartment, but which is so managed that the used-up air heats the cylinder conveying it. It is a good and cheap arrangement, the heat from the cylinder being conveyed into the room to be warmed. By this means heating and ventilation are made subservient to one another. Gas may be used for this purpose with great advantage. Hot-water pipes are sometimes used for a similar purpose. The objections to hot-air shafts are the inequality of the draught, and the alterations which take place from the changes of temperature outside, caused by increase or decrease in the number of people, or the simple alteration consequent upon rises and falls of the barometer and thermometer.

Measurement of Cubic Space.—Length, breadth, and height being obtained, these are multiplied into each

other; it is a simple plan, and the quotient is the answer to the question; but allowances must be made for recesses, for furniture, and for occupants. It is always best to measure by feet and decimals of a foot. If inches are given, they may be turned into square feet by multiplying by ·007. Rules for measurement of triangles, circles, and segments of a circle will be found in the ordinary works on measurement. In measuring a room with a sloping roof, such as a cow-shed or marquee, it is best to take the length, breadth, and height, to the slope, first calculate that portion, then, bearing in mind that the area of a triangle equals its base multiplied by half its height, an approximate estimate may be easily obtained, and when this is arrived at, the quantity of fresh air which must be admitted may be calculated.

Following the syllabus laid down by the authorities at South Kensington, we find the subject of closets, of sinks and baths, to be connected with the removal of waste and impurities, and we take them in order accordingly.

Closets.—These include water-closets, earth closets, middens, privies, cesspools, or any other contrivance for the disposal of human excreta.

Water-Closets are alone suitable for large towns, unless there is an absolute scarcity of water, a commodity which no town is justified in allowing to be scarce. The w.c. should never be placed in or near the centre of a building, but always on an outside wall, and, if possible, in an annexe so that the connection with the sewer may be altogether outside the main wall of the building. No w.c. should be allowed to remain without through ventilation, that is, two communications with the outer air, when the door is shut which leads from the house into the closet. There should be a kind of ante-chamber between the house and the closet, which should have a window; there should also be a window in the closet itself; these windows should not be on the same level. There should always be a cistern for the supply of the closet, and from which water should never be used for dietetic purposes. The overflow pipe from the cistern should not discharge into the w.c. itself, but be so arranged as to act as a tell-tale if the cistern, which is now usually called a waste-water preventive cistern, gets out of order.

(*To be continued.*)

—o—

The New Class-Subject, 'Elementary Science.'

(What to teach, and how to teach it.)

BY RICHARD BALCHIN.

ADOPTING a plan similar to the one sketched for the lower standards, I propose giving the teacher's notes of lessons in this subject of 'Elementary Science' for Standard V. The complete syllabus of the year's work appeared in last month's issue of this magazine. I repeat that these lessons fully embrace the work in the first stage of the specific subject, chemistry, for which the 'Science Reader' for Standard V. (Hughes') forms a good text-book. Perhaps I ought to state that these exceedingly simple notes are intended only as suggesting the plan of lessons, which, after an experience of a quarter or a century, I have found the most effective in presenting the various facts to the minds of boys in the most practical, and, at the same time, most educative manner.

LESSON I.

MATTER AND ELEMENTARY BODIES.

Distinguish between 'matter' and 'non-matter'—between material things and immaterial things. Chalk, wood, ink—material things—can be weighed, measured, handled. Sound, light, electricity—immaterial things—cannot be weighed, handled, etc. Can have a pound of chalk, or a pint of ink; cannot have a pint of light, or a pound of sound. There are different kinds of matter. The matter of coal not the same as that of milk. Some substances made up of more than one kind of matter. Burn chalk, and we get lime—*i.e.*, the heat has expelled something from the chalk and left lime. Therefore, chalk consists of at least two kinds of matter. At the gasworks, coal is heated, a gas is obtained and coke is left. Therefore coal consists of at least two kinds of matter. Burn a candle in an inverted glass vessel over water; the candle soon goes out, and some of the enclosed air has disappeared; what remains is different from ordinary air. Therefore air consists of at least two different kinds of matter. But whatever we may do to gold, iron, lime, sulphur, etc., we cannot find anything else but gold, iron, etc. These consist of but *one* kind of matter, and are called elements. There are about sixty-six known elements. Written language consists of written sentences; sentences of words; words of letters. And here we stop. Letters are the elements of a written language.

LESSON II.—COMPOUNDS.

Letters are the elements of a written language. Letters put together in a certain manner form words. So elementary substances when united in a certain manner form compounds. Oxygen is an element; so is carbon. Burn a piece of carbon (charcoal) in a jar of oxygen gas—*i.e.*, combine the carbon and oxygen, and we get carbon dioxide, CO_2, a compound. Heat some red oxide of mercury in a test-tube. The inside of the tube is lined with the metal mercury and oxygen comes off. Therefore the red oxide of mercury is a compound consisting of the elements oxygen and mercury. Solids unite to form gases: mix a small quantity of powdered charcoal, of powdered sulphur, and of saltpetre (nitrate of potash); set fire to this mixture of solids; they combine and form gases. Place a few fragments of phosphorus (dried) upon a plate; throw upon them a small quantity of iodine; the two elements combine and form a red solid called iodide of phosphorus. Gases unite and form solids: moisten the inside of one tumbler with strong solution of ammonia: place a card over it; moisten the inside of another tumbler with hydrochloric acid, and invert it upon the card on the first tumbler. Both glasses are now filled respectively with the gases of ammonia and hydrochloric acid. Gently draw the card from between the glasses: the gases unite and form dense white fumes, which is solid chloride of ammonia.

LESSON III.—COMPOSITION OF CHALK.

Show picture of chalk pit and limekilns. Chalk is burnt; lime is left. Carbon dioxide is expelled. Therefore chalk consists of lime + CO_2. The lime

that is left contains oxygen. Pure lime we call calcium. Lime, therefore, is an oxide of calcium, CaO. On some pieces of chalk in a beaker, pour some hydrochloric acid. Dip a lighted taper in the vapour rising in the glass; taper goes out in the carbon dioxide driven from the chalk. Hydrochloric acid unites with the remaining lime to form chloride of lime. Do the same with fragments of white marble; hence lead to the general composition of all limestones—*e.g.*, Portland and Bath stones, mountain limestone. Also shells of mollusca, coral reefs, etc. Repeat the burning of carbon in oxygen and recapitulate the explanation of CO_2. Chalk is therefore a compound formed of one part of calcium, one part of carbon, and three parts of oxygen. We write it, $CaOCO_2$; or, $CaCO_3$.

As to the lime, it may be explained that CaO is oxide of lime or quicklime. If water, H_2O, be poured upon it, the quicklime becomes slaked lime, which is hydrate of lime, $Ca(OH)_2$. If chlorine be passed over slaked lime, we get chloride of lime, or bleaching powder. If the boys are above the average in mental capacity, the experiment with chalk and hydrochloric acid may be explained from this point of view, the acid being $HCl + H_2O$.

Lesson IV.—Red Oxide of Mercury.

Why say *red* oxide of mercury? We do not say *white* oxide of lime, or *red* oxide of iron. Because there is *another* oxide of mercury, the *black* oxide. Heat a small quantity of mercury in a test-tube over a spirit lamp, and direct a stream of oxygen upon the boiling metal. At first red scales appear; this is the red oxide, HgO. Instance of combination of elements to form compound. Heat some red oxide in a test-tube over a spirit lamp; the compound splits up; oxygen comes off as a gas; the metallic mercury comes off as the metallic vapour, which condenses upon the inner sides of the test-tube, and forms countless globules of the liquid metal, or, as the boys will probably remark, 'makes the tube like a looking-glass.' Instance of 'decomposition,' as it is termed in the Code Syllabus.

If there is time, another common compound of mercury may be noticed, viz., sulphide of mercury, HgS, (vermilion, or cinnabar; this latter being an ore of mercury, a red-looking stone.) It should also be explained that mercury remains liquid until a cold is reached 72° (−40°) below the freezing-point (32°) of water, when the mercury becomes solid.

Lesson V.—Mixtures and Compounds.

Mix some very fine iron or steel filings with powdered sulphur, 47 parts of iron to 53 of sulphur. Place some of this mixture in saucer No. 1. Burn the rest in an iron saucer over the Bunsen burner. Take a piece of the solid dark-looking substance from the iron saucer, and powder it; place this in saucer No. 2. Pass a magnet over the powder in No. 1; the grains of iron leave the sulphur, and attach themselves to the magnet, leaving the sulphur, which may be ignited by a hot iron wire. This shows that neither the iron nor the sulphur have changed or lost their respective properties by being brought together in this way. Pass the magnet over the powder in No. 2; no iron is abstracted, neither will the powder ignite, showing that when combined in this way, the iron and the sulphur have both lost their respective properties, and we have a substance which is neither iron nor sulphur; it is the sulphide of iron. Mix some powdered charcoal (carbon), sulphur, and saltpetre (nitrate of potash). Place a pinch of the mixture under a microscope; the grains of the several substances are easily distinguishable. No change has occurred. Set a light to the powder, and the whole, or nearly the whole, combines to form various gaseous compounds.

Decompose the compound water by means of the metal sodium, and separate the oxygen from the mixture air by means of phosphorus, as described in the 'Reader.' After these experiments, the boys will supply definitions of 'a mixture,' and 'a compound.'

Lesson VI.—Compounds.

Make solutions in water of the following substances, which very readily dissolve:—Nitrate of lead (No. 1); iodide of potassium (2); chloride of mercury—corrosive sublimate (3); sulphate of iron (4); sulphide of ammonium (5)—this solution had better be purchased; sulphate of zinc (6); infusion of galls (7.) All the above should be quite *clear*. They should be kept in stoppered glass bottles, labelled and numbered. Have a number of test-tubes on a stand, and proceed to form the following compounds:—

Mix No. 1 with some of No. 2. Result:—the formation of iodide of lead, of a brilliant yellow colour.

No. 3 and No. 2. Result;—iodide of mercury, of a brilliant scarlet colour.

No. 4 and No. 5. Result:—sulphide of iron, perfectly black.

No. 6 and No. 5. Result:—sulphide of zinc, perfectly white.

No. 4 and No. 7. Result:—tannate of iron (ink), black.

The above resulting compounds being insoluble in water, are precipitated. The precipitate should be obtained by the two methods of (1) evaporation; (2) filtration.

(*To be continued.*)

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Physiology.

BY ARTHUR NEWSHOLME, M.D. LOND.,

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Chapter XI.—CIRCULATION OF THE BLOOD —(*continued*).

The Circulatory Organs.—The *heart* forms the central organ of the circulation, from which blood is constantly being propelled to every part of the body, and to which it is returned. It is a hollow, egg-shaped organ, lying in the thorax in an oblique position, with the apex downwards and to the left, and the base upwards. On each side it is almost covered by the lungs, a small central uncovered portion being left behind the sternum.

The apex of the heart can be felt beating between the fifth and sixth ribs, about two inches below and an inch nearer the sternum than the left nipple. The base of the heart lies under the sternum on a level with the third costal cartilages. This part of the heart is

comparatively fixed, owing to its connection with the great vessels which run into and from it.

The heart, as well as the commencement of the great vessels, is enclosed in a conical bag, called the *pericardium*. This consists of two layers, an external fibrous layer, which is very strong, and an internal serous layer, which is connected with the outer surface of the heart, and then reflected over the inner surface of the fibrous layer; thus forming a closed or serous cavity, the inner surface of which is beautifully smooth, and secretes a small amount of thin fluid which facilitates the movements of the heart.

In the adult, the heart is 5 inches long, and 3½ inches wide at its base. Its weight in men varies from 10 to 12 ounces, in women from 8 to 10 ounces; its relative proportion to the weight of the whole body being as 1 to 169 in males, and 1 to 149 in females.

The heart is divided longitudinally by a muscular partition into two lateral halves, and a transverse division divides each lateral half into an upper and lower cavity, auricle and ventricle respectively. The right is the venous side of the heart, receiving into its auricle the blood from the veins of the whole body except the lungs; while the left side of the heart receives into its auricle the arterial blood from the lungs.

External grooves indicate the division of the heart into four cavities. A deep transverse groove, known as the auricular-ventricular groove, indicates the separation between auricles and ventricles.

Two inter-ventricular grooves run obliquely down the front and back of the ventricles respectively, separating the two ventricles. The point of junction of the large veins with the two auricles is not marked by the presence of any valves, but for about half an inch from the heart these veins acquire transverse muscular fibres like those of the heart.

Between the right auricle and ventricle is a valve, called the *tricuspid valve*, owing to its presenting three cusps or pointed portions; while at the corresponding point on the left side of the heart, the valve is called the *bicuspid* or mitral, as it has only two chief projecting portions, though there are intervening smaller ones. Each portion of these valves is of triangular form, the base being firmly attached to a ring-like membrane, which encircles the auriculo-ventricular orifice, and serves for the common attachment of the valves and of the separate muscular fibres of the auricles and ventricles. The different valves are joined at their bases, while their apices and sides lie free in the ventricular cavity, except at the moment the ventricle contracts, when they come closely in contact. This contact during the heart's contraction, which prevents any reflux of blood, is further ensured by the attachment of slender tendinous fibres to the free borders and under surface of the valves. These tendinous fibres are known as *chordæ tendineæ*, and they are fixed below to the inner walls of the ventricles, the muscular fibres of which project at intervals in the form of small bundles or columns, called *columnæ carneæ*. Now the *columnæ carneæ* are of three kinds; some are fixed throughout their length to the ventricular wall others are fixed only at their two ends, while a third kind (called *musculi papillares*) are fixed at one end into the ventricular wall, the other end projecting into the cavity, and having attached to it *chordæ tendineæ*.

If these parts be examined in a sheep's heart, the attachment of the chordæ tendineæ to the musculi papillares below, and to the under surface and edges of the auriculo-ventricular valves above can be easily observed, and it will be evident that the effect of contraction of the ventricles and of the musculi papillares which form a part of them, is to draw on the chordæ tendineæ, and cause them to keep the valves in close juxta-position, and prevent any floating back of the valves into the auricular cavities.

Fig. 43.—Theoretical section of Heart, showing the four cavities and origin of large vessels.
(*a*) Aorta; (*bb*) Pulmonary arteries, arising from a common trunk; (*c*) Superior vena cava; (*dd*) Right and left pulmonary veins; (*f*) Right auricle; (*g*) Left auricle; (*h*) Inferior vena cava; (*i*) Right ventricle; (*k*) Left ventricle; (*l*) Inter-ventricular septum.

The ventricles communicate, on the one hand, with the auricles, from which they are separated by the auriculo-ventricular valves; and on the other hand, with the two large arteries (the pulmonary artery and aorta), which carry blood from the heart. The junction of each of these with the ventricle is guarded by three valves, called *semilunar valves*, the only difference between those on the left side of the heart (aortic) and those on the right side (pulmonic), being that the former are thicker and stronger. Each of these valves is formed, like the auriculo-ventricular valves, of fibrous tissue, covered with the delicate lining membrane of the heart or *endocardium*. As the name indicates, each valve is semi-circular in shape, being attached to a fibrous ring at the point of junction of the heart and artery, and projecting inwards. There are no chordæ tendineæ, as in the auriculo-ventricular valves; but each valve is strengthened by a minute fibrous nodule at the centre of its free edge, where the three valves come into contact and become pouched out when the blood makes a futile attempt to return from artery to ventricle.

The main substance of the heart consists of striped muscular fibres, the peculiarities of which have been already described. The muscular fibres of the auricles are quite distinct from those of the ventricles, and we shall find that the two auricles always contract together, driving out their contents, while the ventricles do likewise, immediately after the auricles have finished their work.

The heart requires nutrition, like every other organ of the body, and has therefore a special vascular supply of its own. Its nervous supply is derived from the sympathetic system and the vagus nerve.

The Arteries.—From the left side of the heart, a large arched vessel, called the aorta, carries the blood to every part of the body. From this main trunk branches are given off, which again divide and subdivide, each branch diminishing in size, until the minute capacity of capillaries is arrived at. The total area of all the branches of an artery is greater than that of the original artery. Similarly the area of a trunk vein is much less than that of the smaller veins from which it is formed. The capacity of the minute

arteries, and veins, and capillaries, is thus much greater than of the other parts of the vascular system, and we might represent the arterial and venous systems as two cones, the bases of which join at the capillaries. We know that when a stream widens the current of the water becomes slower; and this is true likewise of the vascular system.

The various arteries in their course anastomose, branches joining together. This is of great importance when any artery becomes obstructed by disease, or severed by accident. The collateral branches usually suffice to carry sufficient blood to the part, and avert dangerous consequences.

Arteries are usually situated in protected parts. Thus at the elbow and knee, they are on the flexor side, and deeply situated. When they are liable to injury from stretching, arteries will be found to be tortuous, thus allowing for tension.

Each artery consists of three coats, an internal or epithelial, a middle or muscular, and an external or fibrous coat. When an artery is tied by a ligature, the two inner are separated from the external coat, and obstruct the flow of blood.

The *inner coat* consists from within outwards of (1) a layer of pavement epithelium, the cells of which shew distinct nuclei. This epithelium is continued throughout the whole of the vascular system, lining the heart and blood-vessels, and giving their interior a beautifully smooth and shining appearance. (2) A sub-epithelial layer, consisting of homogeneous connective tissue, in the midst of which are branched connective-tissue corpuscles. (3) A number of layers of elastic and white fibrous tissue. The innermost of these consists of longitudinal elastic fibres, in which by means of the microscope small apertures may be seen, whence the name given to it by Henle of *fenestrated membrane.*

The *middle coat* consists of unstriped muscle cells, arranged circularly to the course of the vessel. This coat is thicker and redder in proportion in the smaller vessels, in the larger vessels there being a predominance of elastic fibres.

The *external coat* consists mainly of connective tissue, with a variable amount of longitudinally arranged elastic tissue, in all but the smallest arteries, in which elastic tissue is absent.

All the larger arteries are supplied, like every other part of the body, with blood-vessels, called *vasa vasorum.* They supply the external and middle coats with blood, the internal coat probably deriving its nutrition by osmosis from the interior of the vessel. Arteries are likewise supplied with nerves, chiefly derived from the sympathetic system.

The Capillaries.—Harvey, when he discovered the circulation of the blood, had not the advantage of a microscope. He was, therefore, unaware of the minute capillary circulation, which, except in the case of the spleen, the placenta, and certain cavernous structures of the generative organs, forms the means of communication between artery and vein. The transition from arteries to capillaries is very gradual, but the capillaries themselves maintain the same diameter throughout their course. Each capillary consists of a single layer of elongated, flattened, and nucleated cells, forming a delicate continuous membrane, outside which there is usually a structureless, or delicately-fibrillated membrane. The most common diameter of a capillary is $\frac{1}{3000}$th of an inch, though smaller ones are found in the brain and follicles of the intestines, and larger ones in the skin and medulla of bone and elsewhere. The form of the capillary network, into which an artery divides, may be elongated or more rounded, while the distance between the individual capillaries may be less than the width of the capillary, as in the lungs and choroid coat of the eye; or about the same width as the capillaries themselves, as in the human liver; or three or four times the width of the capillaries, as in the human kidney.

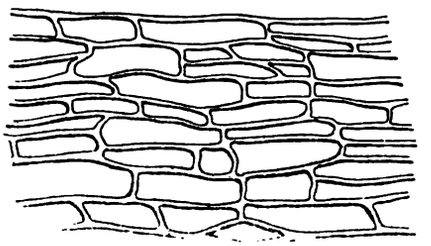

Fig. 44.—Instance of Elongated Capillary Network, as seen in a Voluntary Muscle.

The length of any given capillary probably never exceeds $\frac{1}{30}$th part of an inch. The closeness of the capillary network, and consequently the vascularity of any portion of the body, are in close relation to the activity of its functions.

The Veins.—The general structure of a vein is similar to that of an artery, consisting of three coats having a similar arrangement. There are certain minor differences, however.

(1) The *internal coat* is less brittle than that of an artery, and seldom shows a fenestrated membrane.

(2) The *middle coat* is thinner than that of an artery, and contains a larger proportion of yellow and white fibrous tissue.

(3) The *external coat* is similar to that of an artery, but thicker, and in some veins contains muscular fibres.

The general consequence of these differences is that veins when seen after death are flat and collapsed, while arteries retain their circular shape.

The internal coat of veins presents at intervals semilunar folds, forming *valves*, the free edge of which is turned towards the heart. Generally the valves are placed opposite each other. When the blood is flowing towards the heart, these lie in close apposition to the wall of the vein, but on any attempt at reflux they become pouched inwards, as seen in Fig. 45.

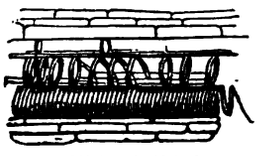

Fig. 45.—Illustrating action of Valves in Vein in preventing reflux of blood.

Valves are commonly absent from veins of less than a line in diameter, and in those which are not subject to the pressure exerted by muscular contractions. The superior and inferior vena cava, the veins entering and leaving the liver, the renal and pulmonary veins, may be mentioned among those which are destitute of valves.

We have already mentioned the prolongation of striated muscular fibres from the auricles for a short

distance into the vena cava and pulmonary veins. There are certain other veins which present peculiarities. In the veins of the gravid uterus, muscular tissue is largely developed, while it is entirely absent from most of the veins of the brain and pia mater, from the veins of the retina, and of the cancellous tissue of bones, and a few other parts.

Veins generally accompany arteries in their course, the currents in the two being parallel, but in opposite directions. They are usually larger than the arteries they accompany, and not uncommonly there are two veins to one artery. Thus the venous system is much more capacious than the arterial. The pulmonary veins form an important exception to this rule. Many veins running in and under the skin are not accompanied by arteries, and in certain internal organs the course of the two does not correspond.

(*To be continued.*)

Article 106 (*b*).

Merit Grant in Infant Schools.

BY MRS. MORTIMER,

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Section II.—Phenomena of Nature.

LESSON—NIGHT AND DAY.

SUPPOSING the lesson to be given in the morning, the teacher should begin thus. When do you go home? What do you do? Have our dinner. And after dinner what do you do? We come to school again. What do you do when school is over? We go home, play about a little after tea, and then go to bed. What part of the day is it when you are in bed? It is night-time. Can you tell me anything about the night? Well, I suppose you cannot tell me much about it as you are all sleeping then. I dare say, however, some of you can tell me something if you try. One little boy says it is quite dark and very quiet. Another one says if we look out of doors we shall see the moon and the stars. Where shall we see them? In the sky. That is quite right; the moon and stars are in the sky. When can we see them? At night. Perhaps some of you remember that we had a long talk about them a little while ago. When does the night begin? When it begins to get dark. What do we call it then? The evening. When does it begin to get dark? When the sun goes down. What do you say the sun does when it goes down? We say the sun sets. Then the evening begins when the sun sets. All of you say, 'The evening begins at sunset.' When does the night end? When it begins to get light. And when is this? When the sun rises. Then you see we can say: 'The night begins at sunset and ends at sunrise.' Is the night always the same length? I am afraid that is too hard for you. Perhaps you can tell me if the sun always shines the same time each day? When does it shine the longest? In the summer. And when does it shine the shortest? In the winter. When shall we have the longest days? In the summer. And if we have long days, what kind of nights shall we have? Short ones. Yes; then all of you say: 'In the summer we have the longest days and the shortest nights.' Now, I daresay you notice that after tea you can no longer go out and play like you did in the summer-time. Is it because you have your tea sooner? Oh, no, we do not have our tea sooner. Well, Mary, what are you going to say? Yesterday the teacher had to light the gas before we went home. Well, then, what shall we say? The day is over sooner now. Yes, and that means that the night begins sooner. In the summer it was quite light when you had to get up, but now what are you obliged to do? Mother has to give us a candle. Yes, and that shows you that the day does not begin so soon, and that the nights are longer. So you see in the winter the nights are longer. All of you say: 'In the winter we have the shortest days and the longest nights.'

Now, what do we call that part of the day when the night ends? The morning. What does the sun do then? It rises Yes, and it keeps on rising until it is high in the sky. What part of the day is it then? We call it *midday*. Yes; and sometimes *noon*.

What do you mean by mid-day. The middle of the day. Yes; what do you generally have then? Our dinner. And what do you call the part of the day after dinner? We say it is *afternoon*. Can you tell me one name for morning, noon, and afternoon? That is right. It is the day. What do your mothers and fathers do then? They work all the daytime. What does your mother do? Keeps the house clean, cooks the dinner, etc. And your father? He goes out to work. How does he seem when he comes home? Very tired. Yes; and then you ought to be quiet and go to bed. Do your mothers and fathers go to bed directly it gets dark? Then how do they see? They have candles or lamps or the gas. Why do they not go to bed? Because they have work to do. Yes; and also because they do not want as much sleep as you do. Little children want a great deal of sleep, it helps them to grow strong. Why do we work in the day and not in the night? Because we can see better in the day. And what else? The night is better for sleeping. You said the middle of the day was called midday, what do we call the middle of the night? *Midnight*. What time is it then? Twelve o'clock. And which part of the night do we call the *evening*? The first part.

Section III.—Scenes of Common Life.

LESSON—A FARM.

If this lesson be given to country children the teacher will have no difficulty in getting them to describe the farm. In giving the lesson to London children, the teacher will have to depend upon the children who have visited the country, and a good picture of the farmyard will be of great service.

Who knows what I mean by a farm? Who has been to a farm? Jane says she went to a farmhouse last summer, so we will ask her to tell us what she saw, and then see if we can find any of the things she tells us about in this nice picture.

What is a farmhouse? It is the house where the people of the farm live. Do you mean all the people that work on the farm? No; the master of the farm and his family. What do we call the master of a farm? The farmer. Where do we say the farmhouses are? They are in the country. Yes; and very often they stand quite by themselves, with no other house near. You might have to walk for many hours before you come to another house. Now, can you tell me what the farm is? Yes, the farmer has a great deal of land on which he grows a great many things. Can you tell me some of the things the farmer grows? Corn, potatoes, hay, and fruit. Yes; he also grows beans, clover, turnips, and many other things. Then he has a number of sheds called barns, in which he puts all these things. And other places for the animals to live in. Can you tell me some of the animals the farmer keeps? Pigs, cows, sheep, fowls, and horses. These live also in the fields. Do you know what grows in these fields? Grass. Well, all these fields, and yards, and barns are called the farm. You now see how it is the farmer often lives a long way from any one else. Which part of the year do you like to go to a farm? In the summer-time. Why? Because everything is growing nicely, and we can run about the fields, and go into the yard and see the fowls and ducks. Does the farmer see to all these places and

animals himself? Oh no, he has several men and women to help him. When you were at the farm what were these men doing? They were cutting down the long grass. What do they do with this long grass? They toss it about and leave it in the field to dry. What do they call it then? They call it hay. Did you like the haymaking? Yes; it was great fun to roll in the hay. You were playing; but the men could not do that, they had to work. You could leave off when you liked, but they were obliged to keep on until they had put the hay up into large stacks, called hayricks. If you had gone to the farm later in the summer you would have seen the farmer's men cutting the corn. Who has seen a cornfield? See, here is one after the corn has been cut. The corn is now in bundles. These bundles are called sheaves, and are very often tied up by women. The corn is then taken to the farmyard and threshed. Do you know what this does? Yes; it knocks the grains of corn out, and only the long stalks are left. What do we call the long stalks of corn? Straw. The grain is sent to the miller, and what does he do with it? He grinds it into flour. Now you have told me that the farmer makes hay and cuts the corn. What must he do to make the corn come? He must sow the seed in the ground. What does he do to the ground first? He has to dig it up. Yes; when your father wants some flowers in the garden, he digs the ground, and then he sows the seed. Now look at this picture. (The teacher points to a picture of a plough.) Do you see these iron knives, and the long handles, and the horses? Well, this is called a plough, and the farmer digs his fields with this. It would take too long to dig the large fields with spades like we do our gardens. When the ploughing is finished the farmer sows the corn, and the turnip-seeds, and other things he wants to grow. While these things are growing (the farmer calls them his crops), the farmer has other things to do. He has to look after the sheep and other animals, and see that they have nice food. What do they eat in the summer? The grass in the fields. Yes; and the farmer grows turnips, potatoes, and other things for them. What do we get from the sheep? Wool. Yes; in the spring the farmer takes the sheep to the pond, and there the men wash the sheep, and then cut all the thick, long wool off. Do you know why he does this in the spring? I will tell you. The sheep do not want all the wool in the warm weather, and so the farmer cuts it off when the summer is coming, and sells it to men who make cloth and flannel of it. Then the cows are very useful, and the farmer must see to them. What do we get from the cow? Milk. Yes; the women milk the cows every morning and evening. What is done with the milk? Some of it is sold, and the rest is made into butter and cheese. Yes, some day I will tell you how the milk is made into butter and cheese. What other animals must the farmer look after? The pigs. Yes; these he fattens and sends to the butcher. What does the butcher call the pig when it is killed? Pork and bacon. The farmer also sells his sheep and cows to the butcher. What do we call the flesh of sheep? Mutton. And that of the cow? Beef. So you see we get our meat from the farmer. Can you think of anything else the farmer has to do? Yes; he must look after the chickens and ducks. Yes; and some farmers keep turkeys and pigeons. What do we get from the fowls and ducks? Eggs. Yes; and the farmer sells all these birds for food. The part of the farm where these birds are kept is called the poultry-yards.

You see, then, the farmer besides looking after the fields has many other things to do. He generally has one particular person to look after the poultry-yard. She goes out regularly to feed the poultry, and it is great fun to see how the fowls and the ducks and other birds all run to her when she comes. Do you know what she gives them? Then she takes away the eggs, and sees that the men keep the place clean.

The children should then write on their slates the names of all the animals on the farm, the different things grown on the farm, and the different kinds of work carried on.

Section IV.—Common Employments.

LESSON—THE GLAZIER.

Apparatus.—A small window frame, a diamond, a rule, hammer, knives, brush, glass, and putty.

Now, children, tell me some of the things that a carpenter makes? Doors, cupboards, windows, tables, etc. Which part of the windows does he make? The wooden part. What do we call that? The window-frame. What else has to be done to finish the window? The glass has to be put in the frame. Does the carpenter do this? What do we call the man who puts in the glass? Yes, that is right, he is called the 'glazier.' Now let us to-day try and find out what the glazier has to do. You have already told me that he puts the glass in the frames. What must he do before he puts it in? Well, here is a piece of glass and a window-frame. Look at it. Could the glazier put it into the frame? Why not? Because it is too large. What must he do? He must cut the glass. Could you cut it? With what does the glazier cut glass? No, not with a knife. See, here is a knife, and you see it will not cut the glass, and yet it is very sharp, for it very easily cuts this piece of wood. He uses a *diamond*. See, here is one. What can you see? A long handle made of wood. What is this at the end? It looks like lead. Yes, it is lead. What can you see in the lead? Something that shines—a piece of glass. It is not glass, but a diamond. Have you ever heard of diamonds? Who has seen one? Where? In a locket. Yes, they are put in lockets and rings because they are very bright and pretty. When next you see them you must notice how they sparkle. Well, this is only a very small one, and not so bright as those in the rings and lockets. Now look, and I will try to cut this glass. Have you seen anything like this? Yes, it is a rule. Well, you place the rule on the glass, and then placing the diamond close to it, you press the diamond on the glass and draw the diamond along. What have I done? Drawn a line on the glass. Try and rub the line off. You cannot. What should we say then? We have scratched a line on the glass. Yes, the diamond has not cut right through the glass. You now take hold of the glass and it breaks very readily along the crack. When the glass has been cut the proper size what next must we do? We must put it in the frame. But see, there is some of the old glass in the frame, so what must we do? Take it all out. How does the glazier do this? He knocks it out. What does he use? A hammer and a knife. Yes, and besides taking out the glass, what else does he do? He takes out all the old putty. Who has seen the glazier using a brush like this? For what? For brushing out any small pieces of glass or putty. Yes, it would not do to use our hands. Can you tell me why? Because the very small pieces of glass might get into our fingers. Now the frame is quite clear, what has to be done? The glass has to be put in. What do you call a piece of glass like this? A pane of glass. Who can put this pane in for me? That is right, but when you take your hand away what will happen? It will fall out. Well, what else do we want? Some putty. Who can find me the putty? What can you tell me about it? It is of a light colour. Anything else? Yes, it is soft. Can any of you show me how the glazier puts the putty on? Yes, he puts it all round the window-frame, and then puts the glass in. What else does he do? He smoothes the putty. How does he do this? With his knife. Is this the knife he used before? No, it is a very smooth one, and not the same shape. The teacher should show the two knives and let the children notice the difference in them. The smooth one is called the glazing or stopping knife, and the other the chopping or hacking knife. Now when the putty is put in and smoothed nicely over, the work is not quite finished. You see the putty is of a light colour, and the window frame is black. What do you think the glazier would do? Yes, he would paint the light putty to make it like the window-frame. You said the putty was soft, and yet the man had to chop out the old putty. Was that soft? Well, then, what would you

say? The putty dries and gets very hard. Yes, and we have to be careful not to rub the window very hard at first. Now tell me all the things the glazier has to do, and write on your slates the names of all the things the glazier uses in his work.

(*To be continued.*)

—o—

Friedrich Fröbel.

BY HIS PUPIL, HEINRICH HOFFMAN.

X.—(*continued.*)

The first Kinder-garten established in Hamburg was conducted by Frau Doris Lütkens, a lady who not only distinguished herself by her professional ability, but who also edited an educational periodical. With untiring energy she laboured to promote the Kinder-garten, and was most ably assisted by a favourite niece of Fröbel, Allwine, the daughter of Middendorff. This young lady afterwards became the happy wife of one whose name will for ever rank among the most zealous writers on the Kinder-garten system, Dr. Wichard Lange, the successful proprietor of a large boys' school which continues to merit the high esteem of the most influential classes in Hamburg. In conjunction with Fröbel he published *Friedrich Fröbel's Wochenschrift*, a weekly paper on the Kinder-garten system (Liebenstein, 1850), and it is to him, who stood in such close connection and constant intercourse with the leading members of the united families, that we owe most of the literature on Fröbel and his work. His lucid style has rendered his writings very popular with all German educationists.

Through the influence of Frau von Marenholtz, the Duke of Meiningen generously offered Fröbel his hunting-box near Marienthal, about a mile and a half distant from Liebenstein, a residence beautifully situated, and close to a charming wood. Here Fröbel enjoyed the evening of his life amidst a large number of pupils, who were boarders, and who revered their paternal friend with touching devotedness. This institute Fröbel designated, in allusion to the end and aim of all his life's aspirations, as *Allseitige Lebens einigung*, a term the exact equivalent of which it is difficult to find in English. (*Allseitig* means all-sided, that which satisfies, or is complete in every direction; *Lebens einigung*, harmonization, unification, of life.)

In order to convince the masses of the excellent results of his plans, or rather, to demonstrate the oneness of all his many contrivances, he arranged a grand festive playing match on the Altenstein, near the ducal palace, on the 4th of August, 1850, the first of its kind ever held. Three hundred children assembled from Salzungen, Meiningen, and the neighbouring villages, and under Fröbel's personal direction performed the various games and gymnastic exercises of the Kinder-garten, to the admiration and delight of a vast number of spectators. It was a day memorable in the history of the Kinder-garten, on account of the immense impression it made, and the enthusiasm it excited in old and young.

The domestic affairs in Marienthal were conducted by a lady who for many years had belonged to the most devoted and most faithful of Fröbel's adherents. But she had long been more to him; she was his intimate friend and regular correspondent. With a clear understanding she combined deep piety and thorough goodness of heart. Her amiability, and the refinement of her manners, won her the affection of all who came near her. We mentioned her name already, when speaking of some pupils of Keilhau. Fraulein Luise Levin was destined to become his second wife in July, 1851. It proved indeed one of those happy unions which we fondly designate as being made in heaven. Pure and holy affection blended the two into one, and the sweet cherub of thorough domestic happiness and contentment took up its abode for awhile in Marienthal, with every one of its many inmates.

Alas! but for awhile! Joy and sorrow are but too often closely linked in this world of ours, and Fröbel's life, apparently made up of dire changes, was destined once more to experience the mutability of all things terrestrial.

As with all human affairs, it was impossible to keep the new idea altogether intact and unpolluted by improper hands. It naturally attracted the attention of all sorts of people, and elements were here and there introduced, to Fröbel's regret, which he abhorred. On the whole, perhaps, he confided too much in the goodness of men, and wherever he found warm reception, he was too ingenuous to suspect improper motives. He judged men after his own standard, believing them to be as pure-minded and noble as himself. Sad disappointments were the necessary consequence. Narrow-minded people would eagerly lurk for anything that might serve to engender distrust, would raise suspicion, and search for flaws. Perhaps, in the order of things, this may be a natural and necessary law, nothing at least proves so much productive of good in purifying a noble cause from anything that is unworthy of it. So we need not wonder that frequently Fröbel's high-souled principles were confounded with such as were objectionable in religious or political parties. But wonder we must at the incomprehensible error which the Prussian Government committed under the ministry of Herr von Raumer.

On the 7th of August, hardly one month after his marriage, a very severe blow was dealt at the work of his life by a ministerial decree, which prohibited the Kinder-garten throughout the entire kingdom of Prussia. The edict opened with the strangest bit of reasoning, thus:—'From a pamphlet, written by *Karl Fröbel*, entitled *Ladies' High Colleges and Kinder-garten*, it appears that the Kinder-garten forms part of the Socialistic system, which aims at training children to atheism. These institutions, therefore, cannot be tolerated.'

It will be remembered that Fröbel, in pious reverence of his deceased brother, Christoph, pastor in Griesheim, had founded his first institute for the benefit of his nephews. One of these was Karl Fröbel, a man of honourable character and of deep learning. The society which had invited Fröbel to Hamburg had appointed him headmaster to a newly-established Ladies' High College. But uncle and nephew differed so much on many essential points, that Friedrich Fröbel repudiated his nephew's principles altogether. Karl Fröbel now lives in Edinburgh. But what must surprise us most is, that the views held by *one* man should have been attributed to another, whose principles were totally different! Every effort to convince the minister of his gross mistake entirely failed. Fröbel sent in all his publications, and offered to undergo a personal examination. But it was all in vain. This strange prohibition remained in force until 1861. In

the eyes of all thinking men there was certainly no need for him to refute the monstrous charge, yet nothing seemed to himself so urgent. Day and night he wrote, whilst from every point of view the ministerial decree was elucidated and repudiated; under the natural excitement the reply enlarged to a volume of such dimensions, that its completion necessarily exceeded his physical powers. Indeed, it was never completed. Though his mind was unbent, his sublime trust in the divinity and in the final victory of his cause remained unshaken. Once, when I ventured to express my feelings with reference to this unparalleled attack, he replied: 'Did you not hear of the wheat found with the mummies in the pyramids? wheat that must have lain there, shut out from the world, for more than three thousand years? And did you hear how Lord Stanhope was permitted to sow a few of these grains, and what an enormous harvest they have yielded? Well, my Kinder-garten is such another grain of wheat. They may close it, they may shut it up in a tomb stronger than the pyramids for another three thousand years, still it will rise, and will flourish; no human power will be able to destroy its vitality, for it is permeated with the everlasting essence of God.'

Indeed, the disastrous storm which had caused so much mischief could not touch the enchanted island in which he dwelt—his beloved Marienthal. Here amidst a circle of sympathising and faithful friends he found peace and happiness, and no one knew better how to enjoy it than Fröbel. That his beautiful garden and grounds were not altogether devastated; that many and many a plant was saved, nay, had grown but stronger, he should learn to his great joy, when at Michaelmas, 1851, a meeting of educationists, in Liebenstein, after three days' discussion, bestowed the highest encomium on him and on his work. Another most gratifying day was his 70th anniversary, 1852. Whatever love and veneration could suggest, whatever mind and heart could plan, to render it a high festival of pious reverence, was realised in a most touching manner.

The last ray of glorious sunshine, however, that illuminated his path, was another great assembly of teachers, at Whitsuntide, 1852, in Gotha, to which he had been formally invited. On his entering the densely-crowded hall, all rose from their seats, the chairman welcomed him in an enthusiastic speech, and offered three times a 'Hoch!' This meeting proved how utterly flat the official censure had fallen on the masses in general, and filled poor Fröbel's heart with warm and refreshing sunlight.

But his physical strength began rapidly to decline. On the 6th of June, 1852, an illness befell him, from which he should not recover but as a citizen of heaven; it was with the setting sun of the longest day, the 21st of June, that his great soul unfolded her wings for the blessed flight home.

The mournful story of his last illness, final departure, and his funeral obsequies, has been most touchingly recorded by Wilhelm Middendorff, in a pamphlet, *Friedrich Fröbel's Ausgang aus dem Leben.*

One year later, November 13th, 1853, and this exemplary friend followed him to the heavenly abode.

Now they are all gone—the united friends—to be reunited in heaven, save Frau Louise Fröbel, who lives in Hamburg, and is still active in the sacred cause, her noble soul ever animated with the memory of her immortal friend. Dr. Wichard Lange is still in full health and vigour, labouring with youthful energy. Keilhau still flourishes as a first-class Institute under the able management of Dr. Siegfried Schaffner, the son-in-law of Christian Fröbel. Although Fröbel and his associated friends have been recalled from their labours, their work lives and flourishes, and with increasing cordiality is their watchword adopted in all parts of the globe—

'COME, LET US LIVE FOR OUR CHILDREN.'*

—o—

My Certificate Answers.

BY ARTHUR DAY,

Assistant-Master, Bridge Street, 7th Standard Technical School, Birmingham; First in the First Class at the Borough Road College, Christmas, 1883.

Algebra and Mensuration.

2. Prove that in taking the square root of a number when $n+1$ digits in the root have been obtained by the ordinary rule, n more may be found by simple division.

Ex. Find $\sqrt{2}$ to 5 places of decimals.

Let N = the given number whose root is required,
a = the part found and having $n+1$ digits,
x = the part to be found and containing n digi s,

Then $\sqrt{N} = a+x$

$\therefore N = a^2+2ax+x^2$

$N-a^2 = 2ax+x^2$

$\frac{N-a^2}{2a} = x + \frac{x^2}{2a}$

Now x contained n digits, so x^2 cannot contain more than $2n$ digits,

But a is made up of $n+1$ digits in front of n o's

So that $\frac{x^2}{2a} = \frac{2n \text{ digits}}{(2n+1) \text{ digits}}$, that is, it is a proper fraction, and neglecting this we have $\frac{N-a^2}{2a} = x +$ some remainder.

Ex. 2·0000 (1·414

1

24) 100 (96

281) 400 (281

2824) 11900 (11296

$\frac{2-(1\cdot414)^2}{2\cdot828} = \frac{\cdot000604}{2\cdot828}$

$= \cdot000213$

$1\cdot414213$. Ans.

3. Solve the equations:—

(1) $4(x-a)^2 = 9(x-b)(a-b)$

(2) $x^2+y^2 = 74$

$x^3+x^2y+xy^2+y^3 = 888$

(1) $4(x-a)^2 = 9(x-b)(a-b)$

Multiplying out: $-4x^2+4a^2-8ax = 9ax-9bx-9ab+9b^2$

Arranging: $-4x^2-(17a-9b)x+(4a^2+9ab-9b^2) = 0$

$4x^2-(17a-9b)x+(4a-3b)(a+3b) = 0$

Factorising this expression,

$\{4x-(a+3b)\}\{x-(4a-3b)\} = 0$

Therefore $x = \frac{a+3b}{4}$, or $4a-3b$.

(2) $x^2+y^2 = 74$

$x^3+x^2y+xy^2+y^3 = 888.$

$x(x^2+y^2)+y(x^2+y^2) = 888$

$74(x+y) = 888$

$x+y = 12$

$x^2+2xy+y^2 = 144$

$x^2+y^2 = 74$

$2xy = 70$

$xy = 35$

* Many of the facts and dates of this essay have been gathered from Dr. W. Lange's *Autobiographiches von Fröbel*, a book previously referred to; and from Bruno Hanschmann's *Friedrich Fröbel, Die Entwicklung seiner Erziehungsidee in seinem Leben.* My own personal recollections were most kindly aided by liberal communications from Frau Louise Fröbel. H. H.

$$x^2+y^2-2xy=74-70$$
$$(x-y)=2$$
$$\begin{cases} x+y=12 \\ x-y=2 \end{cases}$$
$$2x=14$$
$$x=7$$
$$2y=10$$
$$y=5$$

7. The population of a town increases annually 4 p.c., what proportionate addition will be made to the population in a period of 10 years?

log 1·04 = ·017033. log 1·48 = ·170330

y = the amount 1 will increase to

In 1 year 1 increases to 1·04
In 2 years 1 ,, $(1\cdot04)^2$
In 10 ,, 1 ,, $(1\cdot04)^{10}$

Therefore $(1\cdot04)^{10}=y$
$10 \log 1\cdot04=\log y$
$10(\cdot017033)=\log y$
$\cdot17033=\log y$
but $\log 1\cdot48=\cdot17033$
Therefore $\log 1\cdot48=\log y$
$\therefore\ y=1\cdot48.$

The population will increase 48 on every 100 of the original number. Ans.

10. A man who walks up hill at the rate of $2\frac{1}{2}$ miles an hour, and down hill at the rate of 5 miles an hour, ascends and descends a hill in 6 hours, how many miles did he walk, and what was the height of the hill, the rise being 1 in 8?

Let x = time taken in descending (in hrs.)
Then $2x$ = ,, ,, ascending ,,
$x+2x=6 \quad \therefore\ x=2$ hrs.

Therefore the distance walked is 20 miles, and the height of the hill $\frac{1}{8}$ of 10 miles = $1\frac{1}{4}$ miles. Ans.

1. If a quantity is a factor of two other quantities A and B, it is also a factor of mA $\pm$ nB. Prove this and state its application to determining G.C.M. of two algebraical expressions.

Let K be a factor of A and B, and let aK = A, and bK = B.
Then maK = mA and nbK = nB.
$\therefore\ m$A $\pm$ nB = maK $\pm$ nbK = K($ma \pm nb$)
That is, K is a factor of $ma \pm n$B.

Suppose the following to be a G.C.M. :—

B) A (r
rB
C) B (s
sC
D) C (t
tD
...

In the above A = rB + C. B = sC + D. C = tD. D divides C, therefore by the former proof it divides sC + D = B. D divides B and C, therefore divides rB + C = A. Therefore D is a common factor of A and B.

Again, every factor of A and B will divide A − rB (according to our proof).
But A − rB = C.
Also, every factor of B and C divides B − sC = D. Therefore every factor of D is a factor of A, B, and C.
But nothing larger than D can divide D, therefore D is G.C.M.

9. Prove by induction or otherwise that the sum of the series

$$1^3+2^3+\ldots\ldots+m^3=\frac{m^2(m+1)^2}{4}$$

By Induction. By trial we find

$$1^3+2^3=9=\frac{2^2\times3^2}{4}$$
$$1^3+2^3+3^3=36=\frac{3^2\times4^2}{4}$$

We see the rule holds for 2 and 3, digits. Now assume it to hold for k, and let $k+1=m$.

$$\text{Then } 1^3+2^3\ldots\ldots k^3=\frac{k^2(k+1)^2}{4}$$

To each side add $(k+1)^3$

$$1^3+2^3\ldots\ldots(k+1)^3=\frac{k^2(k+1)^2}{4}+(k+1)^3$$
$$=\frac{(k+1)^2\{k^2+4(k+1)\}}{4}$$
$$=\frac{(k+1)^2\{k+2\}^2}{4} \quad \text{But } k+1=m$$
$$=\frac{m^2(m+1)^2}{4}$$

Therefore if it holds for k, it holds for $k+1$; but it holds for 3, therefore it holds for 4, and therefore it holds for 5, and so on universally.

4. A man who saved every year half as much again as he had saved in the previous year had at the end of eight years £26 5s. 5d. How much did he save in the first year?

Let x = amount saved 1st year.
Then $x(\frac{3}{2})$ = 2nd year's savings.
And in successive years
$s=x+x(\frac{3}{2})+x(\frac{3}{2})^2\ldots\ldots x(\frac{3}{2})^7$
This is a Geom. Series.

$$s=\frac{(\frac{3}{2})^8-1)}{\frac{3}{2}-1}.$$
$$£26\ 5s.\ 5d.=\frac{x\left(\frac{6561-256}{256}\right)}{\frac{1}{2}}$$
$$6305 \text{ pence}=x\frac{6305\times2}{256}$$
$$1d.=\frac{x}{128} \qquad x=128 \text{ pence.}$$

10s. 8d. Ans.

8. If the number of permutations which can be formed by n things taken 3 together = 56n, find n.

$$P=n(n-1)(n-2)$$
$$56n=n(n-1)(n-2)$$
$$(n-1)(n-2)=56$$
$$n^2-3n+2=56$$
$$n^2-3n-54=0$$
$$(n-9)(n+6)=0$$
$$n=9$$

9. Ans.

5. (1) If $\frac{a}{b}=\frac{c}{d}=\frac{e}{f}$ then each fraction $=\frac{ma+nc+pe}{mb+nd+pf}$.

Synthetic Method. $\frac{a}{b}=\frac{c}{d} \ \therefore\ \frac{a}{c}=\frac{b}{d}$

Multiply each side by $\frac{m}{n}$, then $\frac{ma}{nc}=\frac{mb}{nd}$

add 1 to each side, $\frac{ma}{nc}+1=\frac{mb}{nd}+1$

$$=\frac{ma+nc}{nc}=\frac{mb+nd}{nd} \quad \therefore\ \frac{ma+nc}{mb+nd}=\frac{nc}{nd}$$
$$\therefore\ \frac{ma+nc}{mb+nd}=\frac{c}{d} \quad \therefore\ =\frac{e}{f}=\frac{pe}{pf}$$
$$\frac{ma+nc}{mb+nd}=\frac{pe}{pf} \quad \therefore\ \frac{ma+nc}{pe}=\frac{mb+nd}{pf}$$

Add 1 to each side, $\frac{ma+nc}{pe}+\frac{pe}{pe}=\frac{mb+nd}{pf}+\frac{pf}{pf}$

$$\therefore\ \frac{ma+nc+pe}{pe}=\frac{mb+nd+pf}{pf}$$
$$\therefore\ \frac{ma+nc+pe}{mb+nd+pf}=\frac{pe}{pf}=\frac{e}{f}=\frac{a}{b}=\frac{c}{d}.$$

(2) If $\frac{y+z}{3b-c}=\frac{z+x}{3c-a}=\frac{x+y}{3a-b}$

then each fraction $=\frac{x+y+z}{a+b+c}=\frac{ax+by+cz}{a^2+b^2+c^2}$

$$\frac{y+z}{3b-c}=\frac{z+x}{3c-a} \quad \therefore\ \frac{y+z}{z+x}=\frac{3b-c}{3c-a}$$

Add 1 to each side, $\frac{y+z}{z+x}+\frac{z+x}{z+x}=\frac{3b-c}{3c-a}+\frac{3c-a}{3c-a}$

$$\therefore\ \frac{y+2z+x}{3b-2c-a}=\frac{z+x}{3c-a}=\frac{x+y}{3a-b}$$
$$\therefore\ \frac{y+2z+x}{x+y}=\frac{3b-2c-a}{3a-b} \quad \text{and by adding 1 and changing sides} \} \text{ as before}$$
$$\frac{2y+2z+2x}{2b+2c+2a}=\frac{x+y}{3a-b}$$
$$\therefore\ \frac{x+y+z}{a+b+c}=\frac{y+z}{3b-c}= \text{ etc.}$$

Mensuration.

3. A hemisphere is partially hollowed so that the interior surface is a right cone with its vertex on the surface of the hemisphere, and with the same base; when the cup thus formed is filled with water, it weighs one-fourth more than when it is empty; find the ratio of the density of the material of which the cup is composed to the density of water.

Vol. of a cone = area of base $\times \frac{1}{3}$ height.
Vol. of hemisphere $= \frac{2}{3}\pi r^3$.
Let r = radius of hemisphere
then vol. of cone $= \pi r^2 \times \frac{r}{3} = \frac{\pi r^3}{3}$

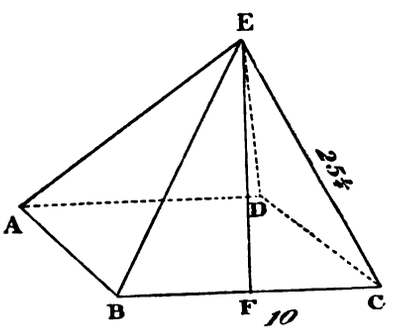
Therefore the cone is half the volume of the hemisphere.
Let D denote the density of water.
,, D_1 ,, ,, ,, cup.
Then

$$\frac{\text{Weight of cup}}{\text{Weight of water}} = \frac{D_1 \times \frac{\pi r^3}{3}}{D \times \frac{\pi r^3}{3}} = \frac{1}{4}$$

$\therefore \frac{D_1}{D} = \frac{1}{4}$.

Therefore the density of the cup is four times that of the water.

1. A pyramid stands on a square base; a side of the base is 10 feet, and each of the edges is 25 feet 3 inches long; find the area of the surface of the pyramid.



Area of base $= 10^2 = 100$ sq. ft.
$FE^2 = EC^2 - FC^2 = (12\frac{1}{4})^2 - 5^2 = \frac{10201}{16} - \frac{400}{16}$
$FE = \sqrt{\frac{9801}{16}} = \frac{99}{4} = 24\frac{3}{4}$ ft.
Area of EBC $= EF \times FC = \frac{99}{4} \times 5 = 123\frac{3}{4}$ sq. ft.
Area of 4 triangular sides $= 4$ (area of EBC) $= 495$ sq. ft.
Area of surface $= 595$ sq. ft. Ans.

French.

SECTION I.—A.

1. Translate into English one of the given selections, and parse the words in italics, and give the principal tenses of the irregular verbs in the passage.

Dumorbion *lui* demanda son épée et posta *des* gendarmes à la porte de son appartement, où entrèrent aussitôt plusieurs officiers supérieurs, qui, *voyant* prisonnier celui qu'ils venaient saluer comme leur général, *firent* éclater, au péril de *leur* vie, une indignation chaleureuse: plusieurs même exhortèrent Hoche à se soustraire par la fuite *à* l'exécrable tribunal devant *lequel* tout prévenu était d'avance un condamné. Hoche *s'y* refusa. Il répondit qu'il se devait à lui-même de paraître devant ses accusateurs, et qu'il ne voulait point donner un exemple qui *pût* servir d'excuse aux traîtres dans l'avenir *ou* dans le passé. Il *leur* parla longtemps avec un sang-froid et une tranquillité qui ne se démentirent pas. Après avoir exposé de quelle manière il croyait que la guerre allait être *conduite* en Italie, il les *pria*, s'ils étaient *de nouveau* témoins de quelques grandes injustices sans doute inévitables, *de* ne pas suivre les conseils d'une irritation toujours funeste. Tous ceux qui étaient présents, ses aides-du-camp surtout, *fondaient* en larmes, mais *lui*, le front serein, le regard toujours fier et doux, s'efforçait *à les* rassurer.

Dumorbion asked him for his sword, and stationed some gendarmes at the door of his apartment, in which entered many superior officers, who, seeing a prisoner he whom they were coming to salute as their general, showed, to the peril of their lives, a warm indignation; many even urged Hoche to avoid by flight the execrable tribunal before which all arraigned were condemned in advance. Hoche refused to do it. He replied that he owed it to himself to appear before his accusers, and that he did not wish to give an example that might serve as an excuse to traitors either in the future or in the past. He conversed with them for some time with a composure and tranquillity that did not belie him. After having explained in what manner he believed the war was about to be conducted in Italy, he prayed them, if afresh they were witnesses of some great injustices undoubtedly inevitable, not to follow the counsels of an always fatal irritation. All those who were present, his 'aides-du-camp' above all, were bursting in tears; but he, with calm brow, his expression continually proud yet sweet, forced himself to reassure them.

Lui—pron., conj., pers., sing., 3rd, masc., complement of 'demanda.'
des—partitive article, plural.
voyant—verb, irr. (voir, voyant, vu je vois, je vis, je verrai), imperfect participle.
firent—verb, irr., 4th conj. (see below for parts), act., trans., ind., past def., plu., 3rd, ag. with subj. 'officiers.'
leur—possessive pronoun.
à—preposition, governing 'tribunal.'
lequel—rel. pronoun, sing., masc., relating to 'tribunal.'
s'y—se, y.
se—reflective pronoun.
y—adverb of place.
pût—verb, irr., 3rd conj., subj., imperf., sing., 3rd, ag. with subj. 'exemple.'
(Subjunctive because following 'voulaient.....que,' expressing a wish.)
ou—conjunction.
leur—pron., conj., pers., plu., 3rd, com., complement of 'parla.'
conduite—past participle of 'conduire.'
pria—verb reg., 1st conj., act., trans., ind., past def., sing., 3rd, ag. with subj. 'il.'
de nouveau—adverb of time.
de—preposition, forming part of verb 'suivre.'
fondaient—verb, reg., 4th conj., neut., ind., imperf., plu., 3rd, ag. with subj. 'ceux (personne).'
'*lui*'—(used instead of 'il' for emphasis) pron., pers., sing., 3rd, masc., subj. to 's'efforçait.'
à—preposition, connected with 's'efforçait.'
les—pron., conj., plu., 3rd, comp. of 'rassurer.'

Irregular Verbs:

Voir, voyant, vu,
Je vois, je vis, je verrai.
Faire, faisant, fait,
Je fais, je fis, je ferai.
Prevenir, prevenant, prevenu,
Je previens, je previns, je previendrai.
Paraître, paraissant, paru,
Je parais, je parus, je paraitrai.
Vouloir, voulant, voulu,
Je veux, je voulus, je voudrai.
Pouvoir, pouvant, pu,
Je peux, je pus, je pourrai.
Dementir, dementant, dementi,
Je demens, je dementis, je dementirai.
Croire, croyant, cru,
Je crois, je crus, je croirai.
Aller, allant, allé,
Je vais, j'allai, j'irai.
Suivre, suivant, suivi,
Je suis, je suivis, je suivrai.

2. Explain the construction of interrogative sentences in French, and translate into French—

'Has she any silk?' 'Yes, she has some.' 'Are you ill, madam?' 'Yes, I am.' 'Are you the Baron's daughter?' 'Yes, I am.'

In interrogative sentences the verb is made to precede its nominative; in compound sentences the auxiliary only is transposed.

A-t-elle de la soie? Oui, elle en a. Avez-vous malade, madame? Oui, j'ai. Etes vous la fille du Baron? Oui, je suis.

3. Translate into French :—

He attends to everything himself; he takes no rest, and allows none to his soldiers. 'Rest,' he says, 'is the rust of courage.' It is winter, the cold is severe, and he does away with tents as useless baggage in a Republican army; the regiments bivouac in the open air; the forests of the Vosges give them shelter and supply their fires; a regiment murmurs and demands winter quarters; Hoche causes it to be entered in the orders of the day that this regiment shall not have the honour of taking part in the action in the first battle. The soldiers of this corps conjure him to revoke an order in which they see an intolerable affront; they take an oath to expiate their fault by their bravery, and they will keep their word.

Il attends à tout lui même; il ne prend aucun répos et n'en donne aucun à ses soldats. 'Le répos,' dit-il, 'est la rouille du courage. C'est en hiver le froid est sévère et il supprime les tentes comme un bagage inutile dans une armée Republicaine: les regiments bivouaquent en plein air, les forêts des Vosges les arbitent et alimentent leurs feux; un regiment murmure et demande des cantonments d'hiver; Hoche fait mettre à l'ordre du jour que ce regiment n'aura point le honneur de participer à l'action dans le premier bataille. Les soldats de ce corps le conjurent de revoquer une ordre où ils voient un intolerable insult; ils jurent d'expier leur faute par leur bravoure et ils tiendront parole.

4. Explain the allusions in the following passages :—

(*a*) 'On eût dit Socrate, au milieu de ses disciples avant de boire la ciguë.'

(*b*) 'En proie au feu qui le dévorait, il se disait revêtu, comme Hercule, de la robe empoisonné du Centaure.'

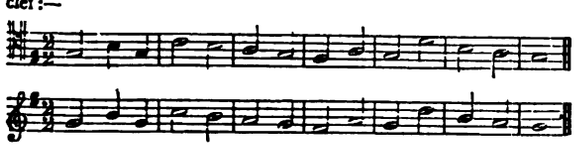
(*c*) 'Hoche se sentait menaçé par un pouvoir muet et invisible; l'épée de Damocles etait sur sa tête.'

(*a*) Socrates, the Grecian philosopher, had many followers, and Hoche comforting his friends before going into captivity is compared for his calmness to Socrates, who drank a cup of hemlock and poisoned himself.

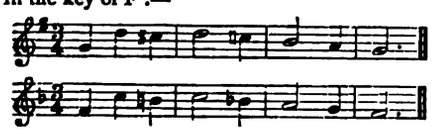
(*b*) The fever that Hoche suffered from is compared to the robe of the Centaur that Hercules slew and which robe he wrapped himself in.

(*c*) Damocles was a courtier of Dionysius, and owing to injudicious remarks, found at a banquet a sword suspended over his head by one hair.

Music.

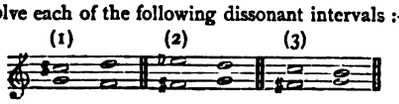
1. Write the following passage one octave higher in the Treble clef :—

2. Under each of the following notes write its letter-name (as C, D, E, &c.) :—

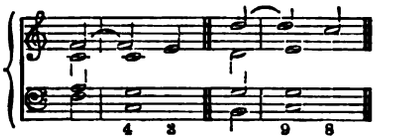
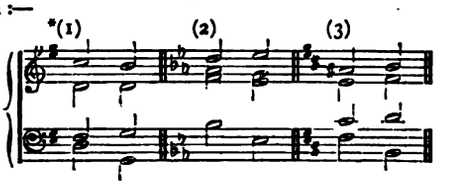
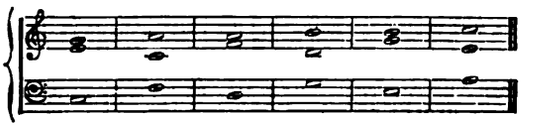
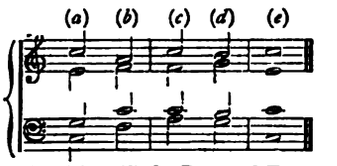
4. Write the following one tone (a major second) lower, namely in the key of F :—



5. Write under each of the following intervals its name (minor third, &c.) :—

8. Resolve each of the following dissonant intervals :—



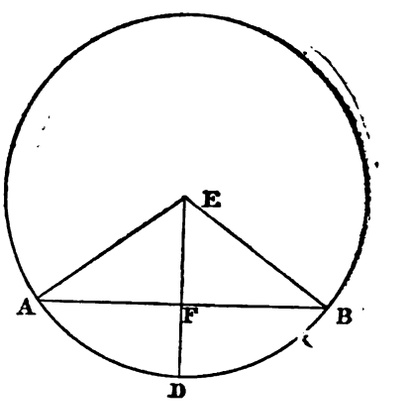
9. Resolve each of the following discords (in four-part harmony) :—

10. Resolve the following direct forms of the dominant seventh :—

11. Complete each of the following common chords (in three parts when completed), by adding (as an Alto part) the note here omitted :—

12. Point out the grammatical faults in the following progressions :—

In the progression (*a*) to (*b*) the Bass and Tenor parts move in fifths.

At (*c*) (*d*) (*e*) the Tenor and Treble are in octaves, adding to which fault the chord (*d*) has the leading-note doubled.

Euclid.

If a straight line drawn through the centre of a circle bisect a straight line in it which does not pass through the centre, it shall cut it at right angles; and if it cut it at right angles, it shall bisect it.

If with the vertex of an isosceles triangle as centre a circle be described cutting the base or base produced, the parts of it intercepted between the circle and the extremities of the base will be equal.



Let AB be a chord, and EF another passing through the centre E.

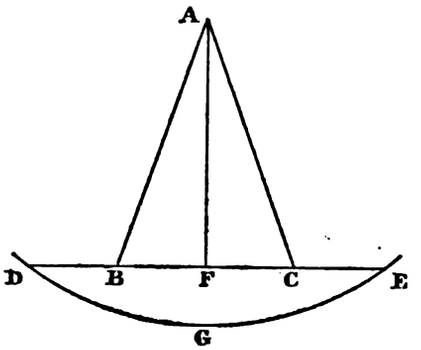
First let EF bisect AB in F.

Then AF=FB (hyp.), AE=EB (I. def. 15).

And the base EF is common. Therefore angle AFE=EFB (I. 8).

Therefore AB is at right angles to EF (def. 10).

Next let EF be at right angles to AB.
Then AE=EB angle EAF=FBE, angle EFA=EFB.
Therefore AF=FB (I. 26).



Let ABC be an isosceles triangle, base BC, and DGE an arc struck with centre A, and cutting the base or base produced in D and E.

From A drop a perpendicular AF to the base.

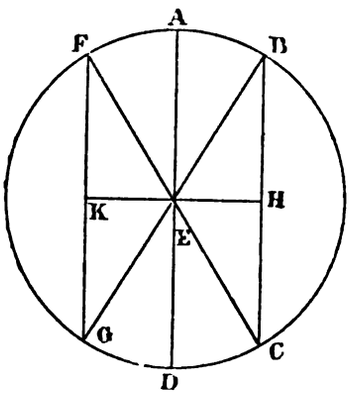
Then AB=AC; angle ABF=ACB (I. 5); angle BFA=AFC; therefore BF=FC (I. 26).

But because AF is at right angles to the chord DE, DF=FE (III. 3).

DF=FE and BF=FC. Take away the equal parts from the whole, and the remainders DB and CE are equal.

4. The diameter is the greatest straight line in a circle; and of all others, that which is nearer to the centre is always greater than one more remote; and the greater is nearer to the centre than the less.

Through a given point within a circle draw the least possible chord.



Let ABCD be a circle, diameter AD, FG and BC other chords.

From E drop perpendiculars to FG and BC.

Join FE, GE, BE, CE.

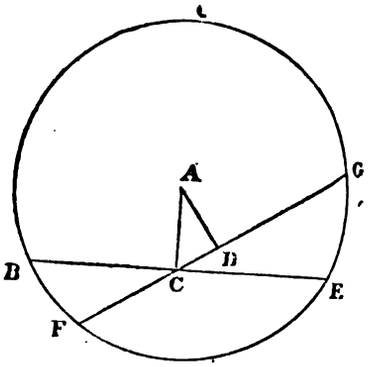
Then FE=AE, GE=ED. But FE, EG are greater than FG (I. 20). Therefore AD is greater than FG. In the same manner it can be proved that AD is greater than any other line in the circle, except it be a diameter.

Secondly, let BC be nearer to the centre than FG. Then BC shall be greater than FG. FE=BE (def. 15). Therefore sq. on FE=sq. on BE. Therefore sqs. on FK + sq. on KE=sq. on BH+sq. on EH (I. 47).

But KE is greater than EH, and therefore sq. on EK is greater than sq. on EH; and therefore the sq. on KF is less than the sq. on EH.

Therefore FK is less than BH. But FG is double of FK, and BC double of BH (III. 3). Therefore BC is greater than FG.

Thirdly, let BC be greater than FG, then EH shall be less than KE. For, as before, sq. on FK+sq. on KE=sq. on BH+sq. on EH. But FK is half of FG, and BH half of BC (III. 3), and BC is greater than FG; therefore FK is less than BH, and sq. on BH is greater than sq. on FK. Therefore sq. on KE is greater than sq. on EH



And KE is greater than EH.

Let C be the given point. Join C to centre A, and through C draw BE at right angles to AC, then BE is the least possible chord.

Draw any other chord FG. From A drop AD perpendicular to FG.

In the triangle ADC the angle ADC is a right angle; therefore ACD is less than ADC, and therefore AD is less than AC (I. 19).

Therefore FG is greater than BE (III. 15). In the same way it can be proved that all chords through C are greater than BE.

To divide a straight line PQ into two parts, so that the rectangle contained by PQ, QR, may be equal to the square on PR.

Prove that rect. PQ, PR+sq. on PR=sq. on PQ, and that rect. PQ, RQ+rect. PR, RQ=rect. PQ, PR.

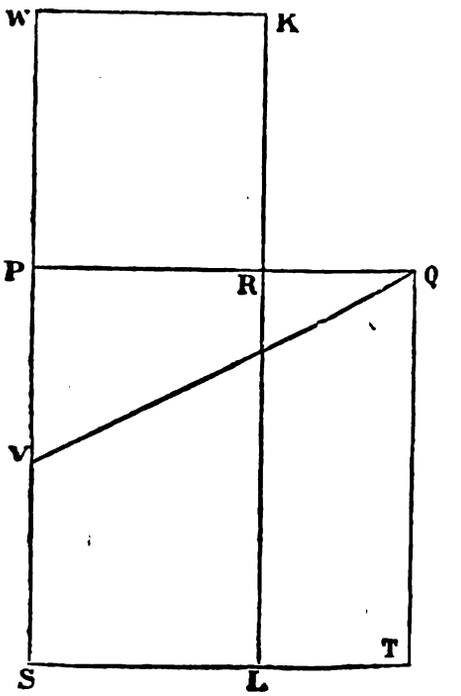
Let PQ be the given line.

On PQ describe a square (I. 46).

Bisect PS in V. Join VQ.

Produce PV to W, making VW=VQ (I. 3).

On WP describe a square PWKR, then R divides the line as required.

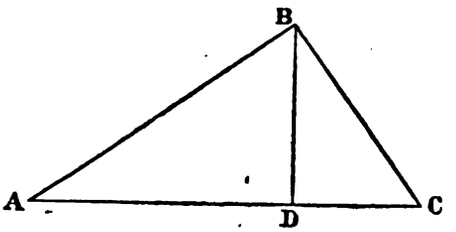


Because PS is bisected in V and produced to W.
Rect. SW, WP+sq. on PV=sq. on WV (II. 6).
Therefore sq. on VQ=rect. SW, WP+sq. on PV.

But sq. on VQ = sq. on PV + sq. on PQ.
Therefore rect. SW, WP = sq. on PQ.
But rect. SW, WP is the figure WL, since WP = WK.
And the sq. on PQ is the figure PT.
Take away the common part PL.
And WR = RT. That is the square on PR = rectangle made up of QT or PQ, and the part RQ.
The rectangle PL is the rectangle contained by PR, PQ, since PS = PQ, and RT = rect. PQ, QR = sq. on PR.
But PL + RT make up the figure PT, which is the sq. on PQ. Therefore sq. on PQ = rect. PQ, PR + sq. on PR.
Since PQ is divided in R, rect. PQ, PR = sq. on PR + rect. PR, RQ (II. 3).
But sq. on PR = rect. PQ, RQ (cons.).
Therefore rect. PQ, PR = rect. PQ, RQ + rect. PR, RQ.

12. In a right-angled triangle, if a perpendicular be drawn from the right angle to the base, the triangles on each side of it are similar to the whole triangle, and to one another. State and prove the corollary.

Let ABC be a right-angled triangle with perpendicular dropped from B to base AC.

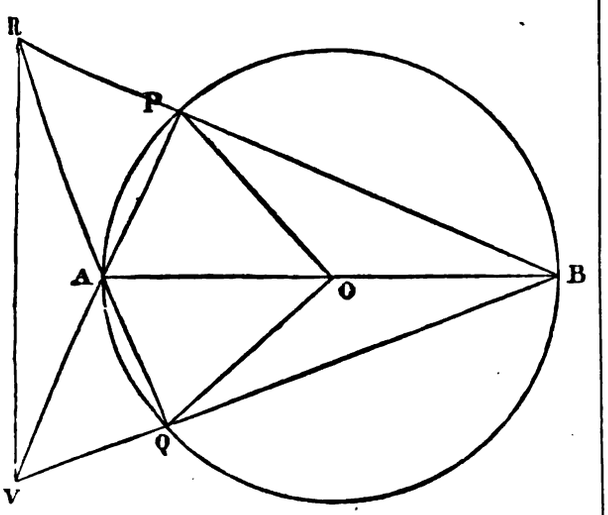


Angle ABC = BDA because both are right angles. Angle BAD is common to the two triangles ABD, ACB. Therefore the remaining angles ABD, BCA are equal. Therefore the triangle ABD is similar to ACB (VI. 4).

In the same way we may prove that BCD is similar to ACB. And therefore, since ABD, BCD are both similar to ABC, they are similar to each other.

Corollary.— The perpendicular BD is a mean proportional to AD, DC. And also AB is mean prop. to AC and AD, and BC is mean prop. to BC, DC.

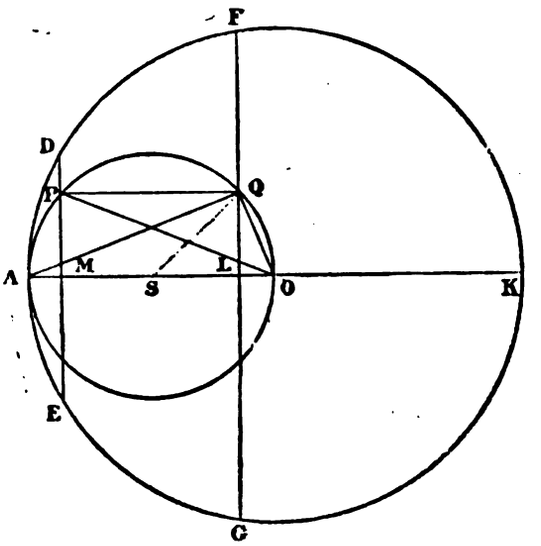
For in the triangles ADB, DBC, AD is to BD as BD to DC (VI. 4).
In the triangles ABC, ABD, AC is to AB as AB to AD.
" " ABC, DCB, AC is to BC as BC to DC.



AB is the diameter of a circle whose centre is O. Through O two radii OP, OQ, are drawn at right angles to each other, and on opposite sides of AB. AQ, BP meet at R, and AP, BQ meet at V. Show that the angle PVQ is half a right angle, and that if RV be joined the angle PO will be twice the angle PVR.

In the triangle PVB, the angle VPB is a right angle (III. 31). Therefore the angles PVB, PBV together make a right angle.
But PBV is half a right angle because it is half of POQ (III. 20). Therefore PVB is half a right angle, and is equal to PBV, and therefore also PB = PV.
In the same way we may prove ARB to be half a right angle.
Again, because RPA is a right-angled triangle, RPA being the right angle (III. 31).
And PRA being half a right angle (part 1).
Therefore PAR = PRA, and therefore RP = PA.
In the two right-angled triangles RPV BPV we have PV = PB (Part 1), RP = PA (part 2).
Therefore the triangles are equal in every respect (I. 4), and therefore RVP = PBA.
But POA is twice PBA (III. 18). Therefore also POA is twice PVR

14. On OA the radius of one circle as diameter another is described, and a chord PQ is drawn in it parallel to OA. If through PQ lines be drawn perpendicular to OA, and meeting the larger circle in D, E and F, G respectively, then the sum of the rectangles contained by PD, PE and QE, QG is equal to the square on the radius of the larger circle.



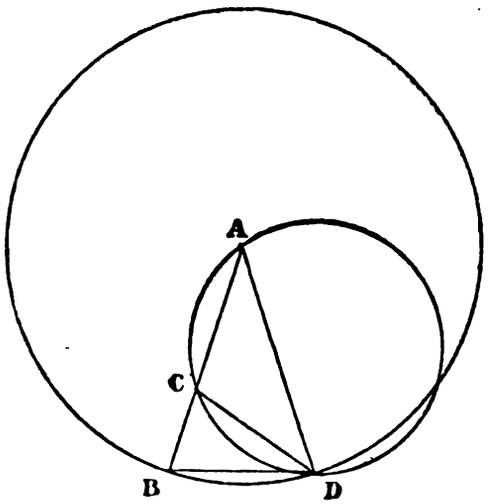
Sq. on FL = rect. FQ·QG + sq. on QL (II. 5).
Sq. on FL = rect. AL·LK (III. 35). Rect. AL·LK + sq. on LO = sq. on AO (II. 5).
∴ sq. on AO = rect. FQ·QG + sq. on QL + sq. on LO.
But sq. on LO + sq. on QL = sq. on QO (I. 47).
Therefore sq. on AO is greater than rect. FQ·QG by sq. on QO.
By an exactly similar process with DP, ME we can get that the sq. on AO is greater than rect. PD, PE by sq. on PO.
Therefore twice the sq. on AO is greater than rect. PD, PE + rect. FQ, QG by the sum of the sqs. on PO + QO.
But because PMQL is a rectangle + PM = QL, MS = SL (III. 14).
Therefore also AL = OM, and PM = QL, and the included angles are right angles, whence AQ = PO (I. 4).
But AQO is a right angle (III. 31).
Wherefore sq. on AQ (that is, sq. on PO) + sq. on QO = sq. on AO.
Therefore twice the sq. on AO is greater than rect. PD, PE + rect. FQ, QG by the sq. on AO.
Therefore the sq. on AO = rect. PD, PE + rect. FQ, QG.

To describe an isosceles triangle having each of the angles at the base double of the third angle.
Divide a right angle into 5 equal parts.
Draw any line AB and divide it at C so that sq. on AC = rect. AB, BC (II. 11).
Describe a circle with centre A radius AB.
Cut off BD in this circle = AC (IV. 1).
Describe a circle through ACD (IV. 5).
Join CD, AD. ABD is the required triangle sq. on BD (= AC) = rect. AB, BC.

Therefore BD touches the circle ACD (III. 37).

Therefore angle BDC=CAD. (III. 32). Add CDA to each of these.

Then BDA = CAD+CDA. But BCD = CAD + CDA (I. 16).



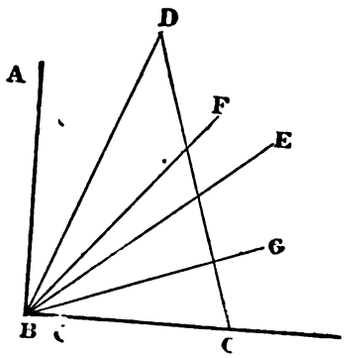
Therefore BDA=BCD (*ax.* 1). But BDA=ABD (I. 5).

Wherefore BCD=CBD, and therefore CD=BD (I. 6).

But BD=CA (cons.). Therefore angle CAD=CDA.

But CAD=BDC. Therefore CAD is half BDA.

Let ABC be the given right angle, and on BC describe an isosceles triangle with the angles at the base double of the vertical angle (IV. 10). Bisect DBC by EB, and then bisect DBE and EBC by FB, GB (I. 9).



Because DBC, BCD are each double of BDC, and the three angles are together equal to two right angles, DBC is two-fifths of two right angles, whence DBE, EBC are a fifth part of two right angles.

Therefore GBC, EBG, FBE, DBF are each one-fifth of a right angle, and therefore ABD is the remaining fifth.

The opposite angles of any quadrilateral figure inscribed in a circle are together equal to two right angles.

If the opposite angles of any quadrilateral be together equal to two right angles, show that a circle may be described round it, and find its centre.

Let ABCD be a quadrilateral inscribed in a circle.

Join BD, AC.

Angle ADB=ABC (III. 21).

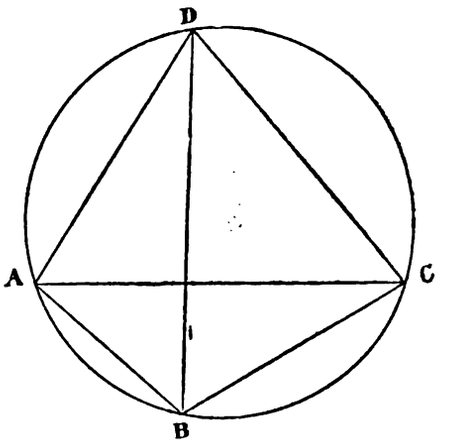
Angle DCA=DBA (III. 21).

Therefore angle DCB=ADB+DBA.

To each add DAB. Then DAB+DCB=ADB+DBA+DAB.

But ADB+DBA+DAB=two right angles.

Therefore DAB+DCB=two right angles.

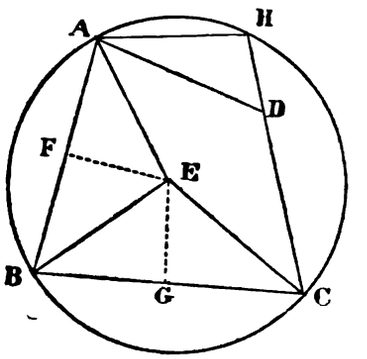


Let ABCD be a quadrilateral having ABC+ADC=Two right angles.

Bisect AB in F, and draw FE at right angles.

Bisect BC in G and draw GE at right angles.

So that FE, GE meet in E. Then a circle described with radius BE, centre E, will pass through AC. For AF=FB. FE is common; included angle is a right angle. Therefore AE =BE, similarly BE=EC.



And this circle will also pass through D, for if not, let it cut DC, or DC produced in H. Join AH. Therefore AHC+ ABC=two right angles.

But ADC + ABC = two right angles. Therefore angle ADC=AHC. That is the exterior angle of the triangle ADH is equal to the interior and opposite, which is absurd.

Therefore the circle cannot pass through H but must pass through D.

History.

1. Recite the chief terms of the treaty between France and England at the close of the Seven Years' War.

England was to retain the following possessions:—Tobago, Dominica, St. Vincent, Grenada, Nova Scotia, and Canada.

She was to give up St. Lucia, Cuba and Havannah, Pondicherry.

England was to receive Florida, Senegal, Minorca.

Certain boundaries were fixed, and rights of fishing, etc., arranged.

Write a brief account of Burgoyne's disastrous campaign and capitulation.

In 1777 General Burgoyne set out from Canada with a body of British troops to push across country and form a connection with the Hudson River, and so cut off the New England States from the others in rebellion. After some early successes he struck boldly out and engaged the Americans, under Generals Gage and

Arnold, at Stillwater, and, though victorious, suffered severely; the enemy, however, succeeded in cutting him off in the rear, and he soon found himself surrounded by a hostile and ever-increasing force. He entrenched himself at Saratoga, and vainly waited for help and relief. So closely did the enemy hem him in that he was unable to employ foraging parties, and at last, supplies failing, he capitulated, and, by the Convention, his troops were allowed to return to England, on condition of not taking any further part in the war.

Give some account of the critical condition of England financially, and as to foreign alliances in the years 1796-97.

The expense of carrying on the war with France was very great, and the Government had to draw very heavily on the Bank. At the same time, the fear of a French invasion led to money being held, and not invested, by persons who were fortunate enough to have it; the consequence of this was that the Government had to resort to paper-money, and it was some time before they were able again to pay in bullion

England was deserted by Prussia and Spain, and then Spain soon after went over to the other side, while the French had also the Dutch as allies, so that England, single-handed, was opposed to all these nations.

Recite the chief provisions of the Act of Union, passed by the Irish Parliament in the year 1800.

(1) That Ireland should have 100 members in the House of Commons.

(2) Twenty-eight peers elected by their fellows to represent them in the House of Lords.

(3) That the Churches of England and Ireland should be united.

(4) And that both countries should have the same privileges of trade and justice.

Give some account of Lord Chatham's Ministry, 1766-1770.

On the failure of the Rockingham ministry, Chatham was induced to take office and form a Cabinet, including among others Grafton, Conway, and Townshend. But Pitt soon became seriously ill, or, at any rate, this was the cause stated for his withdrawal from public life, and the Ministry had to float on without him. Some of their Acts were the duties imposed on articles sent to the colonies, and the persecution of Wilkes. After two years' silence, Chatham reappeared, but by this time the Ministry had changed, Townshend had died, and the Grenville and Rockingham party were linked against him, Lord North was Chancellor of the Exchequer, and the opinions of the Government were no longer Chatham's opinions, and he consequently resigned office.

Who were the chief members of the Ministry of Rockingham? What were the chief difficulties they encountered at the outset?

The chief members of this ministry were the Duke of Newcastle, Grafton, Conway, and Edmund Burke.

They found themselves sadly puzzled how to act towards America; the Colony was in arms against the Stamp Act; Grenville and his party clamoured to have it enforced; Pitt called for its repeal, unconditionally, as being illegal.

The king supported Grenville's view, and a faction called the 'king's friends,' and whom Macaulay describes as a 'reptile body of politicians,' did their best to thwart the Ministry and support the monarch, and they thus had the full force of the opposition; and another body, who, holding Government offices and sinecure places, were counted as supporters, also against them. Besides this they had taken office with the support of the Duke of Cumberland, who had great influence; but soon afterwards he died, and they had among their number only one orator (who had his name to make), viz., Edmund Burke.

Detail the principal causes of the unexampled distress of the years 1816-17 in England.

There had been a very heavy strain on the country by the French war, which had drained men and money and spoilt trade. The Government had consequently had to increase taxes considerably.

To add to this there was a succession of bad harvests, and the importation of foreign corn was restricted by the Corn Bill of 1815. Thus bread was dear, money scarce, and trade bad, and the lower classes would suffer most by all this.

Prepare the outline of a lesson for an advanced class on one of the great measures of reform passed between 1828 and 1837.

REFORM BILL.

Ask who is member for the boys' town or county. How he becomes member, and who elects him, viz., householders or lodgers in boroughs, etc. Select some well-known town in their neighbourhood which has members and another has not; by naming several, draw out the general principle that the number of members depends on the population. Sketch the state of affairs before 1831, describing such places as Old Sarum and Gatton, and the consequent farce of election, also the rioting at elections and the small number of voters, and show the need of reform.

The Passing of the Bill.—Describe the course of the agitation; Lord Grey's Bill; its rejection; the riots at Nottingham, Bristol, aad Derby; the obstruction by peers; and the threat to create new peers; the final passing of the Bill.

Provisions.—Forty-four new boroughs, two members each. Let the boys try to name some of these by recalling the names of towns that have grown rapidly, as Birmingham, Manchester, London, etc. Twenty-one boroughs one member, more county members, several places disfranchised.

Describe the qualifications necessary for voters, and those added by this Bill, such as £10 householders in boroughs. Ask why the time of election should have been reduced, and why counties had two days and boroughs one day allowed. Compare with present time.

Recapitulate, and make complete blackboard sketch.

Composition.

Write in plain prose an essay on *one* of the following:—

(*a*) 'This was the noblest Roman of them all.'

(*b*) 'There is a tide in the affairs of man,
Which, taken at the flood, leads on to fortune.'

(*c*) 'Unto bad causes swear
Such creatures as men doubt.'

(*b*) A voyager embarking at a port would often find that though everything seemed in readiness for an immediate start, still the vessel waits and waits, and the captain watches the water until at last he seems satisfied. and gives the order to let go. If the traveller, impatient of the delay, inquired of a sailor the reason for the apparent waste of time, the answer would be, 'We're waiting for the tide, sir,' and further questioning would elicit the explanation that the vessel could only cross the harbour bar at the flood tide. This is evidently the kind of incident that was in Shakespeare's mind in writing the words that head this paper. In the scene where the words occur, Brutus and Cassius are consulting as to the future movements of their forces. Brutus urges immediate action and attack, Cassius suggests waiting for the enemy's onslaught, when the former replies that their cause is ripe, their friends are all with them, and that future delay will only be running the risk of desertion, and this view he urges with the speech, 'There is a tide, etc.'

Most men in reviewing their life can look back on some period when their mode of action has led, either to continued after success, or, on the other hand, to years of failure or mediocrity.

Who in reading the life of Lord Beaconsfield can help admiring the tact of the man in seizing the opportunity of Sir R. Peel's acceptance of the Anti-Corn Law League, to combine his fortunes with those of the disappointed Tories, and abuse their once-admired leader; and many other noted men have attained their eminent position mainly by means of the clear foresight that has led them to embark on their enterprises at the critical period which would command success.

Grammar.

Paraphrase the following passages, and comment briefly upon the words italicised:

Vexed I am
Of late with passions of some *difference*,
Conception only proper to myself.
Which give some soil perhaps to my behaviours.

'Tis a common proof,
That lowliness is young ambition's ladder,
Whereto the climber-upwards turns his face,
But, when he once attains the upmost round,
He then unto the ladder turns his back,

Looks in the clouds, scorning the base *degrees*
By which he did ascend.

Swear priests and cowards and men *cautelous*
Old feeble *carrions* and such suffering souls
That welcome wrongs; unto bad causes swear
Such creatures as men doubt; but do not stain
The even virtue of our enterprise,
Nor the insuppressive mettle of our spirits,
To think that or our cause or our performance
Did need an oath.

These *couchings* and these lowly courtesies
Might fire the blood of ordinary men
And turn *pre-ordinance* and first decree
Into the law of children. Be not *fond*
To think that Cæsar bears such rebel blood
That will be thaw'd from the true quality
Like that which melteth fools.

I have lately been sorely perplexed by contending emotions and with thoughts which concern me alone, and which somewhat sully and spoil my demeanour towards others.

It has very often occurred to me that humility is like a ladder which assists a man to rise. While climbing he turns his face towards it, but when once he has attained the desired eminence he turns round, no longer caring for those steps that helped his ascent, but viewing the wide expanse of heaven.

Priests and cravens, deceitful men, and faint-minded old persons are those from whom you should require an oath, and from those who delight in wrong-doing. Oaths are needed when the cause is bad, and when the performers of the act are untrustworthy; but our cause is not of this class, and we should only tarnish the moral excellence of our undertaking, and our strength of purpose by supposing that either need an oath to bind them.

All this stooping and prostration might puff up some men with pride, and cause them to alter their previous decisions with the captiousness of children. Do not be so foolish as to think that Cæsar's blood is so easily inflamed as to lead him astray in his actions.

Difference—that are in conflict one with another.
degrees—the steps or rungs of the ladder.
cautelous—crafty or cautious, first meant cautious, then suspicious, then crafty or deceitful.
carrions—carcases, used contemptuously.
couchings—stoopings, prostrations, to 'couch' is to stoop or bend low.
pre-ordinance—things decreed from the beginning.
fond—foolish, still used in the north part of England with this meaning.

Explain the ides of March—I had as lief not be—the cross blue lightning—no fleering tell-tale—richest alchemy—the genius and the mortal instruments—the eighth hour—wilt thou lift up Olympus?—signed in thy spoil—cry 'Havoc'—Cæsar's angel—abjects, orts, and imitations.

The ides of March.—The 13th of some months and the 15th of others was called 'the ides.' The ides of March would be the 15th.
I had as lief not be—I would as willingly not exist.
The *cross* blue lightning—the zigzag path of the lightning.
No fleering tell-tale—no grinning or sneering sneak.
Richest alchemy.—Alchemy professed to change base metal into gold.
Genius and the mortal instruments—the soul and the bodily powers.
Wilt thou lift up Olympus?—Olympus, a mountain in Greece. The question is asked to imply, Wilt thou try to do an impossible thing?
Signed in thy spoil—linked together at thy capture.
Cry 'Havoc'—raise a cry of slaughter without giving any quarter.
Cæsar's angel—was like his guardian angel, so inseparable was he from him.
Abjects, orts, and imitations—castaway pieces, odds and ends, and mocking others.

Show the truthfulness of the following lines:—

Yon grey lines
That fret the clouds are messengers of day.

I am constant as the northern star.

Hollow men, like horses hot at hand,
Make gallant show and promise of their mettle.

In watching a sunrise, the even dulness of the sky would be observed to change, and a few lines break the clouds, then gradually spreading and changing colours.

The northern or pole star is said to be the centre of the heavenly systems, and our axis points to it, hence it never changes its position in the heavens.

Those horses that prance much and are restless are often thought to be splendid animals, and seem to be only too eager to perform great feats. So with hypocritical persons; they promise much, but perform but little of it.

Point out any grammatical peculiarity in the following:—

I'll about.—A verb of motion (as turn) omitted before an adverb or preposition, common in Shakespeare.
Be not jealous on me.—'On' used for 'of.'
What need we any spur.—'What' for 'why.'
And that were much he shall.—'Much' means 'hard,' and that is put before 'were.'
Let no man abide this deed but we the doers.—'Abide' is used transitively, as in 'I cannot abide it,' and 'we' is subject of 'will abide it,' which is understood.
There is tears for his love.—'Tears' plural and 'is' singular. 'Tears is there.'
Ay, and truly you were best—i.e., 'it were best for you.' The objective pronoun put before the verb.
As the flint bears fire who shows a hasty spark.—'Who, which we use only for person, here refers back to a neuter thing, 'fire.' 'We should say 'that' or 'which.'
Only I yield to die.—The place of the adverb 'only' changed from behind the verb to before the subject.

Write an analysis of the Essay on Study, explain and illustrate from your own reading, books to be 'read by deputy,' to be 'swallowed,' and the best cure for 'wandering wits.'

Studies are for delight, ornament, and improvement of mind or intellect.
Too much study is idleness and laziness.
Used too much for ornament is affectation.
To judge solely by, and depend entirely on, weakness.
They must be linked with and controlled by experience.
Read to weigh and consider.
Some books read—
(1) Only in part.
(2) Others scanned through.
(3) Others wholly and carefully.
(4) Others by deputy.
Reading makes a full man.
Writing an exact man.
Conversation a ready man.
Different studies serve different purposes.
As Mathematics—to give power of concentration.
History—a knowledge of the ways of the world.
Logic and Rhetoric—argumentative power.

Books 'to be swallowed,' such as novels, descriptions of historical characters, or adventures, give one a general knowledge, but would be waste of time to study carefully every detail.

'Read by deputy.' Large volumes, such as Mill's 'Political Economy,' or Hamilton's 'Mental Philosophy,' which are too compendious for students in college to wade through, but if read by the tutors, and abstracts given of the parts most useful to them, the abstracts would be of great value.

Best cure for 'wandering wits.' Mathematics. It is no use trying in a half-hearted style to study Euclid, for instance; for if we let our wits wander, and once drop the thread of the demonstration it is necessary to begin all over again.

Name some of the 'false points of praise'; and point out how praise may be judiciously employed.

False points of Praise—When it is only flattery or praising to one's hurt, maliciously, either to him, and so cause him to be conceited, or to others to excite jealousy. Over-praising one.
Judicious use of Praise—If a boy has done a difficult task, praise will be a reward to him, and stimulate him to further effort. If the praise be public, others will also be excited to emulation.

State briefly the antithesis between the conduct of the young and the old, suggested in Bacon's essay on 'Youth and Age.'

Youth.	Age.
Quick in invention and imagination.	Slow, but sure.
Good at carrying out new projects, or acting under fresh circumstances.	Better in counselling things already known than in adapting to new circumstances.
Err through rashness.	Fail in not acting quickly enough.
Undertake more than they can fulfil.	Consult too long, object too much, and are too careful of not adventuring money where it may be lost.
Do not wait to calculate ways and means.	Are governed by the power of understanding.
Act by impulse of will and affections.	

The Discipline of the Mind.

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VI.—The Will and its Training—*(continued).*

Much of the war of words that has been waged in respect of this question of the nature and extent of Will would have been rendered unnecessary, if it had been always understood that pleasure and pain are, in strict language, not 'motives' at all, except in relation to a character. Exaggerated stress laid upon the external factor, the represented pleasure and pain, has led to human beings being considered the creatures of circumstance; an excessive attention to the internal factor has given rise to the idea of a metempirical entity, playing at times the part of a *deus ex machina* by interfering with the psychical mechanism, a pure potency whose reality and actuality are far from being synonymous. It is here maintained that it is impossible (except logically) to separate will and manifestation of will, and that what we have to consider is the quite definite relation of the active side of mind to feeling. Frequently, it must be said, the feelings are of a very subtle and concealed kind, so that they do not form portions of distinct consciousness, and somewhat of the mystery that has hung round these voluntary processes is doubtless due to this circumstance; for it is by no means always possible to peer into the dark laboratory where the forces of the mind are elaborating in silence their marvellous products. But however obscure the subject always in detail remains, we know sufficient of the process now to clearly formulate the problem, and can always translate the fictitious abstractions of the schools into the language of concrete consciousness. We shall not be disturbed, *e.g.*, by associations of a metaphysical nature that have gathered round such a term as that of 'choice,' for instance. We shall regard it as a short expression for the fact that any particular resolution is chiefly dependent upon the internal factor, the spiritual fabric, which, although known in the main, will, in large part, always be unknown until revealed at the moment of action. The *selection* is due to that which is somewhat vaguely styled 'the character,' which in part resembles, and in part is unlike, that of other individuals. This character is liable to modification, and hence the 'choice' may vary with the very same persons with the very same motives, for between the two occasions of choosing the individual may have been submitted to influences which render the situation a different one. Room is therefore found at this point for the part of the educator, and we accordingly pass to the consideration of the Training of the Will.

Let the nature of the problem be quite understood. Given human minds with certain susceptibilities and propensities, how to induce the adoption of a particular line of conduct. The methods will be different to some extent according to the numbers attempted to be influenced. An orator in dealing with a vast multitude can only appeal to the broadest principles of human nature. He must consider the multitude before him as a single plain individual, a being simplified to the mental and moral structure possessed by the average of mankind, and therefore not below the level of the time or much above it. In the same way the disciplinarian in dealing with a large body of youths; average juvenile nature must be assumed, and the discipline must be calculated for the average. But it is the same thing whether we deal with the average of a large number or the mean stratum of the nature of any one individual; and hence we may assume in all discipline of the will that certain motives will influence all alike. The *appetites* are common to all. The instinctive cravings which have reference to the life-preserving functions can be taken for granted as uniformly strong. Now the satisfaction of these primordial cravings up to a certain limit is essential for healthy existence, and the only danger here is of undue interference. As a rule, it may be taken for granted that the child knows its own wants best when these wants have reference to self-preservation. But there is, of course, a dubious margin; and for this reason, that a gratified appetite is wont to make its appearance hereafter in the guise of desire. A desire is a state of mind wherein we are subject to the fascination of some pleasure, now ideal, whose sweetness we have already tasted in the reality. Now as the gratification of all appetites is attended with pleasure, it is quite possible for the pleasure to become a distinct object to the mind, and for the craving to arise when there is no real need of the system. Besides the appetites, whose gratification is essential for healthy existence, there are secondary desires due to a certain way of living, a certain social environment, to anything, in short, which continued for a sufficient time comes to be craved so ardently that its absence is keenly felt. It is not always, indeed, easy to discriminate, especially in an advanced stage of civilisation, between those cravings which are of the essence, as one might say, of our being, and those recurring needs which have come to be a part of our ordinary life-routine. Directly, however, pleasure becomes an object for its own sake, we get an effective leverage for controlling the will. But the difficulty of the case is this, that, save in the case of the absolute needs of the constitution, the susceptibility varies so much that a very different discipline is necessary in some cases than in others. Next to primary appetite I think one might say that *sociality* is the strongest of all cravings. Of all modes of punishment at least absolute solitary confinement has always been recognised as the most painful, and resort to even a small measure of it should be very sparingly exercised. As we must not yet enter, however, upon the general subject of moral education, but confine ourselves to the psychology of the will, we must be content with the foregoing illustrations of the endeavour to force an association between a certain course of conduct and consequent pain or pleasure. Of the two species of association the latter is by far the more desirable, but it cannot be said that it is the more forcible. There

is no mind, indeed, so fortunate in its constitution as to be guided by the lure of pleasure alone, and hence the one application of pain becomes the gravest of problems. There is, indeed, a self-rectifying power in both disciplines, for pleasure grasped in excess passes into pain, and pain applied beyond a certain point renders the nature obtuse and insensitive.

The end to be achieved in the discipline of the will is to raise a pleasure or pain *in idea* to the intensity of a pain or pleasure in reality, to make the individual act as he would act if the solicitation were there in all the urgency of a present feeling. It will be obvious that the most imaginative mind has the best chance of conforming his conduct aright without any extraneous aid in the shape of rewards and punishments. And undoubtedly it is so; only imagination may be strong or weak in relation to quite different things. But even so guarded, the remark will not be true unless along with the imagination can be the conviction of realisation. Now there is not always this co-existence between a vivid imagination and belief. We may very vividly depict all the harmful consequences of some indulgence, and yet have a secret hope that such consequences may be in some way averted. It is the characteristic of a normal mind to adjust its action to the probabilities of the prospective pains and pleasures. It is the mark of an unsound mind to see the better, and yet follow the worse, to be so possessed by an idea as to seek fruition utterly regardless of consequences. When action is not capable of being proportioned to motive the will is paralysed, and what training is possible must have for object the restoration of the physical or mental balance. But, if there be no derangement of the volitional mechanism, the processes available for attaining that self-mastery which lies at the foundation of all progress are the following.

As thoughts and feelings come and go according to purely natural law, it is frequently necessary to interfere with the current succession, and to turn into other channels, or wholly to subdue the energy of emotion. To accomplish these ends it is indispensable to acquire a habit of attention. We must gain the power of singling out certain less conspicuous portions of the train of thoughts, letting all else go, and dwelling upon the chosen objects until they occupy the whole field of consciousness. The lesson may be begun in the simplest act of observation, where the natural tendency to dwell on more striking objects is thwarted, and the gaze is concentrated on uninteresting details. So important is the acquisition of this power in the development of the will, that it is often the only weapon at our disposal for gaining the victory in the warfare of the inner life. The importance of it may be imagined when we reflect that the intellectual rains are always at the mercy of chance suggestions, hat there is no guarantee for correct associations eing formed in the haphazard conjunctions of rdinary experience. The firmest associations may in this way get formed before any selective power has been exercised.

The emotions exert their influence either directly in the shape of powerful, spontaneous impulses, or indirectly through association with some special ideas. The waves of feeling, never wholly insignificant, sometimes gather an unexpected strength, the causes being wholly unconscious, or an idea may leap into life in consequence of some casual suggestion. To subdue our emotions directly by sheer force of will is impossible. The most effective course is to play one off against another. It is, indeed, a misuse of language to describe will as a source of energy; the office of the will is directive. The energy of the system is supplied by feeling. The control of any feeling, then, is either by releasing the springs of a contrary feeling, as when hate is quenched by love, or by diverting the emotional stream, by fixing the attention on thoughts that are linked with other more desirable feelings. The difference between the man of weak and of strong will lies in this, that the former allows himself to be at the mercy of the passing thought or transient emotion; the latter allows the thought of injurious consequences to act as a new motive, in addition to the present impelling forces. We have, at opposite ends of the volitional scale, the amiable yielding temperament, which gives up at the first assault, whose actions cannot be calculated upon, and the hard, unbending character to which the bare love of power ranks as sole motive. Where the one is self-destructive, by allowing its strength to be undermined, the other crushes, not controls the sensuous nature, and seals up the fountains of emotion. The desirable temperament is flexible without being weakly concessive, attains its ends with a due regard to changing circumstances. It requires a nice tact to know when to yield to the pressure of feeling, when to call up the opposing force of a permanent ideal. Man is not to be the sport of blind nature, but to be a law to himself. He has to rise out of the Fate of Nature, but in obedience to certain norms that are impersonal, which are valid not only for himself, but for all men. Self-control does not mean self-assertion. It means giving that weight to the various impulses which is their due as part of a well-ordered system.

To return, then, to our method of self-control. Its conditions and limits are well-defined. As volition means action determined by feeling (the only motor-feelings being pleasures and pains), a rightly directed volition signifies action not according to what we do feel, but according to what we should feel. Any instance of acquired self-command will illustrate the process. To be simply borne along by an impulse may be highly pleasurable, to follow some favourite pursuit, to read some enticing book (the opening for the training of the youthful will is usually afforded by such an instance); but a foresight of remote consequences reveals the greater worth of another course of conduct, for the moment painful, but productive of a more lasting pleasure, say the mastering of a scientific treatise. Only a highly-developed intelligence can be expected to vividly realise the advantages of such a course of action, and the strength of the motive-power must be increased by the coercive discipline of pain for neglect, that is by making the following the present impulse less pleasurable than performance of the prescribed task. But no educator will be satisfied by a merely coercive policy. Enforced obedience may engender habit, but habit thus produced is apt to degenerate into slavery. The last stage of the educational process consists in the calling into play one supreme motive, *pleasure in the exercise of original power*. When an end aimed at is accepted as our own end, then for the first time is the action rightly described as freely chosen or pre-eminently voluntary.

In the education of the will two things are especially to be kept in view. The one is, that progress must at

first be very gradual. The control of thought, the direction of feeling, cannot proceed beyond a certain pace. To ask for much self-denial at the outset is to be utterly unreasonable. The other is, that each success is to be regarded as a *plus*, every failure as a *minus* quantity. Each victory over present inclination for the sake of a more distant good makes, quite independently of the law of habit, the chance of a second victory easier by giving a new motive, viz., the memory of a victory achieved, and therefore adds a fresh stimulus to exertion. On the other hand the memory of failure is an obstructive force; the second attempt will be more arduous than the first, the natural inertia of the system being reinforced by a certain amount of belief that voluntary effort itself is vain. Hence the egregious folly of requiring efforts beyond the individual strength. Unless there is a probable certainty of success the will should not be called upon; an easier task must first be attempted; the inexperienced warrior must win his spurs on a less dangerous field.

(To be continued.)

Recent Inspection Questions.

[*The Editor respectfully solicits contributions—all of which will be regarded as* STRICTLY PRIVATE—*to this column. For obvious reasons, it cannot be stated in which district the questions have been set.*]

Arithmetic.

STANDARD II.

(1) 33,880 × 78. Ans. 2,642,640.
(2) 50,904 ÷ 9. Ans. 5,656.
(3) 76,372 − 49,080. Ans. 27,292.
(4) 13,865 × 309. Ans. 4,284,285.
(5) 71,016 ÷ 8. Ans. 8,877.
(6) 74,986 − 29,308. Ans. 45,678.

STANDARD III.

(1) A girl had 11s. in her pocket. Her brother gave her 5s.; he then had 8s. left. How much more, at first, had he than his sister? Ans. 2s.

(2) A man was born in 1569 and he died in 1670. Another man born in the same year died in 1680. How much was one older than the other?
Ans. 10 yrs.

(3) What number multiplied by 747 will bring the same answer as 87 multiplied by 249? Ans. 29.

(4) What number multiplied by 747 will bring the same answer as 27,380 − 13,934? Ans. 18.

STANDARD IV.

(1) If 10 pennies standing one upon another measure an inch, how much money is there in 100 heaps standing 4 feet high? Ans. £200.

(2) How many inches in 2 miles 20 yds.?
Ans. 127,440.

(3) 60 ac. 4 rds. 14 per. 19 yds. to feet.
Ans. 2,661,142½ ft.

(4) £312 15s. 9d. ÷ 508.
Ans. £0 12s. 3¾d. + 48

(5) A field is 1000 acres. How many acres are there in 110 fields? Ans. 110,000.

(6) If a man's income is £50 per quarter year, and he spends 8s. a week, what does he save?
Ans. £179 4s. 0d.

(7) £4,763 18s. 9d. × 5,010.
Ans. £23,867,326 17s. 6d.

(8) A forest of 5,024 acres was cut into fields, each containing 110 yds. How many fields were there?
Ans. 221,056.

[N.B.—The fields are each less than an ordinary village school-room;—exquisitely ridiculous.—ED. of P. T.]

(9) A sum of money was distributed among 97 men and 87 women; each man got £1, 3 shillings, 2 half-crowns, and 5 sixpences; each woman got half as much as a man. What was the amount of money?
Ans. £214 5s. 3d.

STANDARD V.

(1) $\frac{3}{5} + \frac{1}{7} + \frac{9}{10}$. Ans. $1\frac{9}{14}$.

(2) If I walk 120 yds. in 1 minute, how long will it take to go 3 miles? Ans. 44 min.

(3) A farmer pays a ¼d. rent for every square yard of his farm. His whole rent is £363. Find the size of the farm in acres. Ans. 72 acres.

(4)

17 lbs. at 2½d. per lb.	£0	3	6½
5½ lbs. at 1s. 6d. per lb.	0	8	3
7 lbs. at 2s. 6d. per lb.	0	17	6
5 tins, each containing 17 lbs. at 7d. per lb.	2	9	7
Ans.	£3	18	10½

(5) 676 articles at £7 18s. 10½d. each.
Ans. £536 19s. 6d.

(6) $\frac{1}{2} + \frac{3}{4} + \frac{1}{8} + \frac{7}{8}$. Ans. $2\frac{7}{24}$.

(7) Find the value of 6 cases each containing 17 cwt. 2 qrs. 21 lbs. at £2 14s. 0d. per ton.
Ans. £14 6s. 6$\frac{9}{20}$d.

(8) 4 men dig a drain 69 yds. long in 42 days; how long will it take 10 men to dig the same drain?
Ans. 16$\frac{4}{5}$ dys.

N.B. Mental Arithmetic taken throughout. Not severe.

Grammar.

STANDARD II.

To underline nouns and verbs in dictation.

STANDARD III.

Each scholar to pick out one part of speech from dictation.

STANDARD IV.

Parse:—
(*a*) The bear lives near the sea
(*b*) For he likes to swim in the water.

STANDARD V.

Analyse and parse:—
(*a*) By-and-by up comes the round head of the seal.
(*b*) Sometimes he dives into the water after a fish.

Dictation.

All the dictation was taken from the 'Royal Readers.'

STANDARD II.

(*a*) Page 95.—'There was.....before him.'
(*b*) Page 101.—'The lion.....in Asia.'

STANDARD III.

(*a*) Page 101.—'When he reached.....same time.'
(*b*) Page 99.—'The butler .....best policy.'

STANDARD IV.

(*a*) Page 68.—'A Swiss hunter.....down the cliff.'
(*b*) Page 68.—'Chamois hunting.....their escape.'

Reading and Recitation.

In Standards II., III, and IV., the 'Royal Historical Readers' and 'Royal Geographical Readers' were used, each being read alternately.

In Standard V., 'Robinson Crusoe.'

The repetition was severe throughout.

Geography.

STANDARD II.

Name the oceans. Name the continents. Point to each. What is an island? Point to and name islands on the map of world. What is a lake? Point to one in England. What is a peninsula? Point to one in England. What is a bay? Point to one on the map.

STANDARD III.

Relative positions of counties in South of England—boundaries—islands in mouth of Thames—capes—bays—islands off south coast—towns in south counties.

STANDARD IV.

Name islands north of Scotland which are nearest to Scotland—islands on west. How many groups? Largest of outer Hebrides—a town on it. Largest of inner group. What do we get from Skye? What separates the two groups? River on the west of Scotland. Chief town on the Tay—what noted for? What town is a port for whale fishers? Town near Firth of Forth—what is its port? What is Dunfermline noted for? What is Paisley noted for? Town on Clyde? What is Aberdeen noted for?

Where is St. John's? British North America? What is between Erie and Ontario? How far do they fall? Where is Newfoundland? New Brunswick? What is the Fraser River noted for? Rivers flowing north? Where is Halifax? Manitoba? Rocky Mountains? Vancouver Isle?

(Inspector asked children to point out places on the map.)

Publications Received.

Bell (G.) and Sons—
Sallusti; Catilina et Jugurtha. By G. Longman.

Blackie and Son—
Robinson Crusoe.
Readings from Sir Walter Scott, with Notes.
Adventures in Field, Flood, and Forest.
The Pirate Island. By Harry Collingwood.
Brothers in Arms. By F. Bayford Harrison.
Stories of the Sea in Former Days.

Chambers (W. and R.)—
Elementary Hygiene. By T. London.

Davies (H. G.)—
The Queen and Her Relations (a genealogical table).

Fisher Unwin (T.)—
Easy Lessons in Botany. By E. Step.
First Natural History Reader.
Heroic Adventure.
Plant Life. By E. Step.

Heywood (John)—
Analysis of the Book of Judges. By Lewis Hughes, M.A., and the Rev. T. Boston Johnstone.

Hodder and Stoughton—
Meg's Mistake. By Mrs. R. O'Reilly.
A Long Lane with a Turning. By Sarah Doudney.
Just in Time. By Mrs. G. S. Reaney.
The Orient Boys.
The Autocrat of the Nursery. By L. T. Meade.

Jakeman and Carver—
The Oxford and Cambridge French Reader. By Frédéric Hunt.

Jarrold and Sons—
Geography. Standards I. to VII.
Arithmetic. Standards I. to VII., and Answers.
Summary of English History.
} Young England School Series.

Johnston (A.)—
Johnston's Object Lesson Pictures for Schools. Fruit Trees:—Olive, Peach, Bread Fruit, Vine, Fig, Pomegranate.

Kegan Paul and Co.—
Higher Education in Germany and England. By C. Bird.

Longmans and Co.—
Virgil's Æneid. Book XII. (Dr. White's Grammar School Texts.)
Longman's Magazine. October.
The Elements of Music. By F. Davenport.
Key to the Art of Solving Problems in Higher Arithmetic. By Rev. J. Hunter, M.A.

Miscellaneous—
The Cornhill Magazine. October (Smith, Elder and Co.)
A Catalogue of the Japanese Exhibits at the Health Exhibition. (W. Clowes and Sons, Limited.)
Letts's Illustrated Household Magazine for October.

Maclehose (J.) and Sons—
German Grammar. By Clemens Schlomka, M.A., Ph.D.

Murby (T.)—
Algebra for Beginners. Stages I., II. and III. By W. Dodds.
Langton's Examples in Arithmetic. Standard VII.

Nelson (T.) and Sons—
The World at Home. Standard VI.

Nisbet (J.) and Co.—
Lays and Ballads of Heroism. By H. J. Barker.

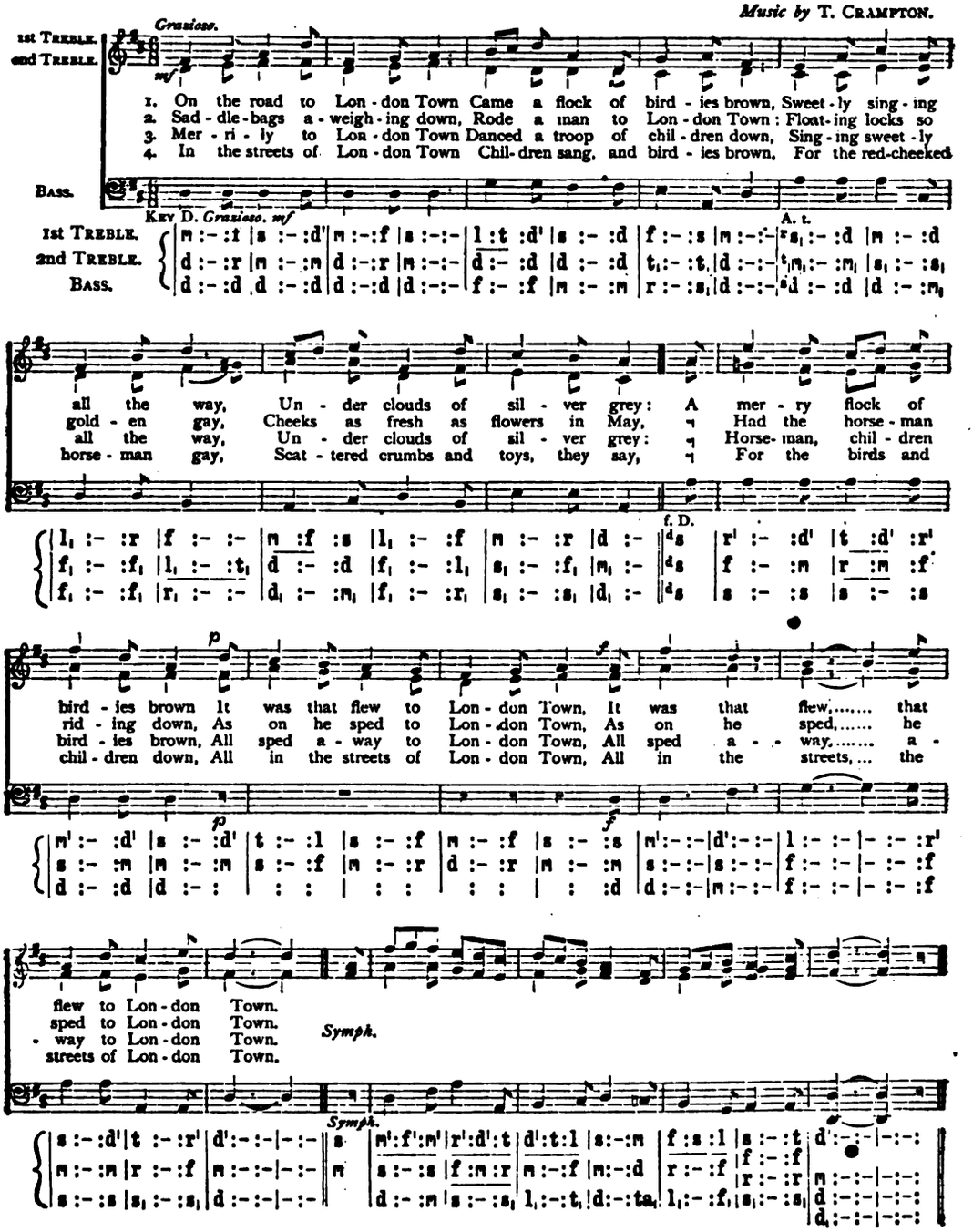
Robertson (G.) and Co., Limited—
Grammar and Logic. By J. W. F. Rogers.

Stanford (E.)—
The London Geographical Reader. Book V.

The Oxford University Press—
The Church of England Sunday Service Book.

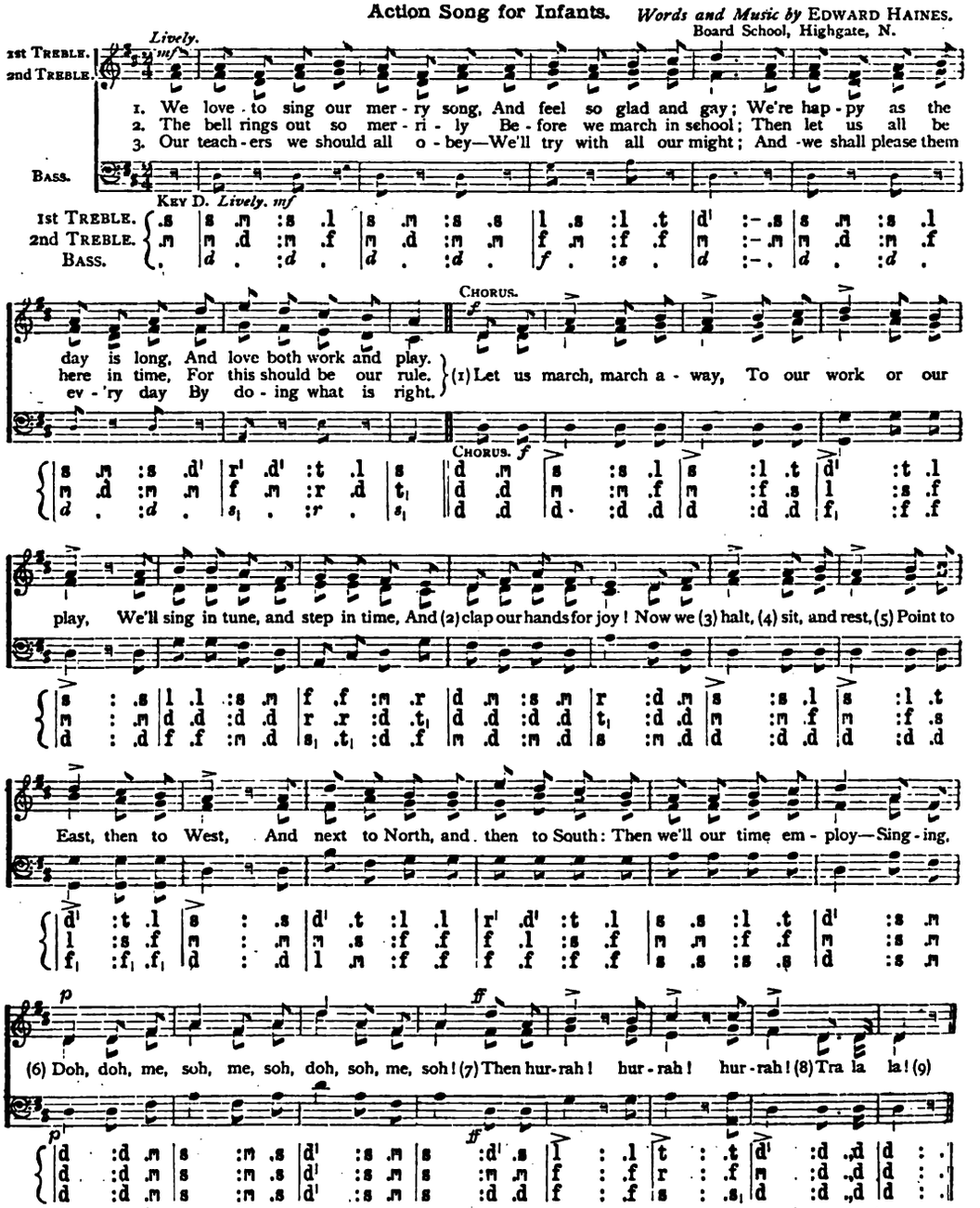
ERRATA.—In October number of PRACTICAL TEACHER, on page 361, for £129 *read* £112 17s. 6d., and for £146 5s. *read* £135. On page 360, for 3 *read* $3\frac{8}{11}$.

LONDON TOWN.

Music by T. CRAMPTON.

1st TREBLE.
2nd TREBLE.
BASS.
Grazioso.
mf
1. On the road to Lon-don Town Came a flock of bird-ies brown, Sweet-ly sing-ing
2. Sad-dle-bags a-weigh-ing down, Rode a man to Lon-don Town: Float-ing locks so
3. Mer-ri-ly to Lon-don Town Danced a troop of chil-dren down, Sing-ing sweet-ly
4. In the streets of Lon-don Town Chil-dren sang, and bird-ies brown, For the red-cheeked
KEY D. Grazioso. mf
A. t.
all the way, Un-der clouds of sil-ver grey: A mer-ry flock of
gold-en gay, Cheeks as fresh as flowers in May, Had the horse-man
all the way, Un-der clouds of sil-ver grey: Horse-man, chil-dren
horse-man gay, Scat-tered crumbs and toys, they say, For the birds and
f. D.
bird-ies brown It was that flew to Lon-don Town, It was that flew,..... that
rid-ing down, As on he sped to Lon-don Town, As on he sped,..... he
bird-ies brown, All sped a-way to Lon-don Town, All sped a-way,..... a-
chil-dren down, All in the streets of Lon-don Town, All in the streets,... the
p
f
flew to Lon-don Town.
sped to Lon-don Town.
way to Lon-don Town.
streets of Lon-don Town.
Symph.

"The Practical Teacher" Music Competition—Second Prize (Action Songs).

WE LOVE TO SING OUR MERRY SONG.

Action Song for Infants. *Words and Music by* EDWARD HAINES.
Board School, Highgate, N.

Lively. mf
1st TREBLE.
2nd TREBLE.
BASS.
1. We love to sing our mer - ry song, And feel so glad and gay; We're hap - py as the
2. The bell rings out so mer - ri - ly Be - fore we march in school; Then let us all be
3. Our teach - ers we should all o - bey—We'll try with all our might; And we shall please them
KEY D. Lively. mf
1st TREBLE.
2nd TREBLE.
BASS.
CHORUS. f
day is long, And love both work and play.
here in time, For this should be our rule.
ev - 'ry day By do - ing what is right.
(1) Let us march, march a - way, To our work or our
CHORUS. f
play, We'll sing in tune, and step in time, And (2) clap our hands for joy! Now we (3) halt, (4) sit, and rest, (5) Point to
East, then to West, And next to North, and then to South: Then we'll our time em - ploy—Sing - ing,
p
ff
(6) Doh, doh, me, soh, me, soh, doh, soh, me, soh! (7) Then hur-rah! hur - rah! hur - rah! (8) Tra la la! (9)
p
ff

NOTE.—If desirable, let one fourth of children be selected to sing verses, and the whole class join in chorus.—(1) Mark time. (2) Clap also. (3) Cease marching and clapping. (4) Sit. (5) Point in direction indicated. (6) Class beat time with forefinger on palm of left hand. (7) Rise, wave the arm above the head, and deliver the hurrahs with enthusiasm. (8) Clap to time. (9) After last verse add quick clapping, similar to ordinary applause.

Query Column.

RULES.

1. Each correspondent is restricted to *one question*. We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.

2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.

3. ☞ When a pseudonym is adopted it should be written at the end of the query, and the real name and address on a separate piece of paper.

4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.

5. Replies will not be sent through the post.

6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—'*The Query Editor*,' *The Practical Teacher*, *Pilgrim Street, Ludgate Hill, London, E.C.*

Algebra.

1. WELSHMAN.—Prove that

$$4xy(x^2+y^2)=(x^2+xy-y^2)^2-(x^2-xy+y^2)^2.$$

(*Todhunter.*)

$$(x^2+xy+y^2)^2-(x^2-xy+y^2)^2$$
$$=x^4+x^3y^2+y^4+2x^3y+2x^2y^2+2xy^3$$
$$-(x^4+x^3y^2+y^4-2x^3y+2x^2y^2-2xy^3)$$
$$=x^4+x^3y^2+y^4+2x^3y+2x^2y^2+2xy^3-x^4-x^3y^2-y^4+2x^3y$$
$$-2x^2y^2+2xy^3$$
$$=4x^3y+4xy^3$$
$$=\underline{4xy(x^2+y^2)}.$$

2. G. T. D.—In the Quadratic Equation $x^2+ax+b=0$ show that $-a$ = the sum of the roots.

Solve the equation $2x+\sqrt{x^2+7x+23}-25=0$.

(*Scholarship.*)

$$x^2+ax+b=0$$
$$x^2+ax=-b$$
$$x^2+ax+\left(\frac{a}{2}\right)^2=\frac{a^2}{4}-b$$
$$=\frac{a^2-4b}{4}$$
$$x+\frac{a}{2}=\frac{\pm\sqrt{a^2-4b}}{2}$$
$$\therefore x=\frac{\pm\sqrt{a^2-4b}-a}{2}.$$

$$\therefore \text{Sum of roots}=\frac{\sqrt{a^2-4b}-a}{2}+\frac{-\sqrt{a^2-4b}-a}{2}$$
$$=\frac{-2a}{2}$$
$$=\underline{-a}.$$

$$2x+\sqrt{x^2+7x+23}-25=0$$
$$\sqrt{x^2+7x+23}=25-2x$$
$$x^2+7x+23=625-100x+4x^2$$
$$x^2-4x^2+7x+100x=625-23$$
$$-3x^2+107x=602$$
$$x^2-\frac{107x}{3}=-\frac{602}{3}$$
$$x^2-\frac{107x}{3}+(\frac{107}{6})^2=\frac{11449}{36}-\frac{602}{3}$$
$$=\frac{11449-7224}{36}$$
$$=\frac{4225}{36}$$
$$x-\frac{107}{6}=\pm\frac{65}{6}$$
$$x=\pm\frac{65}{6}+\frac{107}{6}$$
$$\therefore x=7, \text{ or } \frac{86}{3}.$$

The value $\frac{86}{3}$ does *not* satisfy the equation; therefore $\underline{x=7}$.

3. UNITY.—Solve:—

$$2x-\{(2x+1)-(3x-6)\}=35-3[2x-\{10-(2x-1)\}].$$

(*Jones and Cheyne.*)

$$2x-\{(2x+1)-(3x-6)\}=35-3[2x-\{10-(2x-1)\}]$$
$$2x-\{2x+1-3x+6\}=35-3[2x-\{10-2x+1\}]$$
$$2x-\{7-x\}=35-3[2x-\{11-2x\}]$$
$$2x-7+x=35-3[2x-11+2x]$$
$$3x-7=35-3[4x-11]$$
$$3x-7=35-12x+33$$
$$3x+12x=68+7$$
$$15x=75$$
$$\therefore \underline{x=5}.$$

Note.—Perhaps 90 per cent.

4. INQUISITIVE.—Simplify, exhibiting work in full:—

$$\frac{x}{(x-y)(x-z)}+\frac{y}{(y-z)(y-x)}+\frac{z}{(z-x)(z-y)}.$$

(*Edinburgh University Senior Certificate*, 1884-5.)

$$\frac{x}{(x-y)(x-z)}+\frac{y}{(y-z)(y-x)}+\frac{z}{(z-x)(z-y)}$$
$$=\frac{x}{(x-y)(x-z)}+\frac{y}{(y-z)\times-(x-y)}+\frac{z}{-(x-z)\times-(y-z)}$$
$$=\frac{x}{(x-y)(x-z)}-\frac{y}{(x-y)(y-z)}+\frac{z}{(x-z)(y-z)}$$
$$=\frac{x(y-z)-y(x-z)+z(x-y)}{(x-y)(x-z)(y-z)}$$
$$=\frac{xy-xz-xy+yz+xz-yz}{(x-y)(x-z)(y-z)}$$
$$=\underline{0}. \text{ Ans.}$$

5. CORRESPONDENT.—Solve:—

$$2\left(x^{\frac{1}{n}}+x^{-\frac{1}{n}}\right)=5. \quad (\textit{Todhunter.})$$

$$2\left(x^{\frac{1}{n}}+x^{-\frac{1}{n}}\right)=5$$
$$x^{\frac{1}{n}}+x^{-\frac{1}{n}}=\tfrac{5}{2}$$
$$x^{\frac{1}{n}}+\frac{1}{x^{\frac{1}{n}}}=\tfrac{5}{2}$$
$$x^{\frac{2}{n}}+1=\tfrac{5}{2}x^{\frac{1}{n}}$$
$$x^{\frac{2}{n}}-\tfrac{5}{2}x^{\frac{1}{n}}=-1$$
$$x^{\frac{2}{n}}-\tfrac{5}{2}x^{\frac{1}{n}}+(\tfrac{5}{4})^2=-1+\tfrac{25}{16}$$
$$=\tfrac{9}{16}$$
$$x^{\frac{1}{n}}-\tfrac{5}{4}=\pm\tfrac{3}{4}$$
$$x^{\frac{1}{n}}=\pm\tfrac{3}{4}+\tfrac{5}{4}$$
$$=2, \text{ or } \tfrac{1}{2}$$
$$\therefore \underline{x=2^n, \text{ or } 2^{-n}}.$$

6. C. H. DUNN.—A man borrows from another the sum of £400 at 4 per cent. per annum. The whole is to be paid off by annual payments of principal and interest in 30 years. State the sum required to be paid each year.

Let A denote an annual payment in pounds, n the number of years, R the amount of one pound in one year, and P the amount of the loan in pounds.

$$\text{Then, } PR^n = \frac{R^n - 1}{R - 1}A,$$

$$\therefore\ 400 \times (\tfrac{104}{100})^{30} = \frac{(\frac{104}{100})^{30} - 1}{\frac{104}{100} - 1}A,$$

$$\left.\begin{aligned}\text{Log. } (\tfrac{104}{100})^{30} &= (\log. 26 - \log. 25) \times 30\\ &= (1{\cdot}4149733 - 1{\cdot}3979400) \times 30\\ &= {\cdot}0170333 \times 30\\ &= {\cdot}5109990\\ &= \log. 3{\cdot}243389\end{aligned}\right\}$$

$$\therefore\ 400 \times 3{\cdot}243389 = \frac{3{\cdot}243389 - 1}{\frac{4}{100}}A,$$

$$16 \times 3{\cdot}243389 = 2{\cdot}243389A,$$

$$\therefore\ A = \frac{51{\cdot}894224}{2{\cdot}243389}\ £$$

$$= £23\ 2s.\ 8d. \quad \text{Ans.}$$

7. G. S.—If $\frac{a}{b} = \frac{c}{d} = \frac{e}{f}$,

$$\text{then each fraction} = \frac{ma + nc + pe}{mb + nd + pf}.$$

$$\text{If } \frac{y+z}{3b-c} = \frac{z+x}{3c-a} = \frac{x+y}{3a-b},$$

$$\text{then each fraction} = \frac{x+y+z}{a+b+c} = \frac{ax+by+cz}{a^2+b^2+c^2}.$$

(*Certificate Exam.*, 1883.)

$$\text{Let } K = \frac{a}{b} = \frac{c}{d} = \frac{e}{f};$$

$$\text{Then, } Kb = a,\ Kd = c,\ Kf = e;$$

$$\therefore\ m(Kb) + n(Kd) + p(Kf) = ma + nc + pe,$$

$$K(mb + nd + pf) = ma + nc + pe,$$

$$\therefore\ K = \frac{ma + nc + pe}{mb + nd + pf}.$$

$$\text{Let } K = \frac{y+z}{3b-c} = \frac{z+x}{3c-a} = \frac{x+y}{3a-b};$$

$$\text{Then, } K(3b-c) + K(3c-a) + K(3a-b) = y+z+z+x+x+y,$$

$$3Kb - Kc + 3Kc - Ka + 3Ka - Kb = 2(x+y+z),$$

$$2K(a+b+c) = 2(x+y+z)$$

$$\therefore\ K = \frac{x+y+z}{a+b+c}.$$

$$K(a+b+c) - K(3b-c) = x+y+z-(y+z),$$

$$K(a+b+c-3b+c) = x+y+z-y-z.$$

$$K(a-2b+2c) = x,$$

$$K(a^2 - 2ab + 2ac) = ax;$$

$$K(a+b+c) - K(3c-a) = x+y+z-(z+x),$$

$$K(a+b+c-3c+a) = x+y+z-z-x,$$

$$K(2a+b-2c) = y,$$

$$K(2ab + b^2 - 2bc) = by;$$

$$K(a+b+c) - K(3a-b) = x+y+z-(x+y),$$

$$K(a+b+c-3a+b) = x+y+z-x-y,$$

$$K(-2a+2b+c) = z,$$

$$K(-2ac + 2bc + c^2) = cz;$$

$$\therefore\ K(a^2 - 2ab + 2ac + 2ab + b^2 - 2bc - 2ac + 2bc + c^2) = ax + by + cz,$$

$$K(a^2 + b^2 + c^2) = ax + by + cz,$$

$$\therefore\ K = \frac{ax + by + cz}{a^2 + b^2 + c^2}.$$

8. ESSAYIST.—If $a_1 : b_1 = a_2 : b_2$, show that

$$\frac{m_1a_1 + m_2a_2}{m_1b_1 + m_2b_2} = \frac{a_1}{b_1}.$$

$$\text{Let } K = \frac{a_1}{b_1} = \frac{a_2}{b_2};$$

$$\text{Then, } Kb_1 = a_1,\ Kb_2 = a_2;$$

$$\therefore\ m_1(Kb_1) + m_2(Kb_2) = m_1a_1 + m_2a_2,$$

$$K(m_1b_1 + m_2b_2) = m_1a_1 + m_2a_2,$$

$$\therefore\ K = \frac{m_1a_1 + m_2a_2}{m_1b_1 + m_2b_2}.$$

$$\therefore\ \frac{m_1a_1 + m_2a_2}{m_1b_1 + m_2b_2} = \frac{a_1}{b_1}.$$

9. SOLICITOR.—If $a_1 : b_1 = a_2 : b_2 = a_3 : b_3$, show that $a_1^2 + a_2^2 + a_3^2 : b_1^2 + b_2^2 + b_3^2 :: a_1^2 : b_1^2$.

(*Hamblin Smith.*)

$$\text{Let } K = \frac{a_1}{b_1} = \frac{a_2}{b_2} = \frac{a_3}{b_3};$$

$$\text{Then, } Kb_1 = a_1,\ Kb_2 = a_2,\ Kb_3 = a_3;$$

$$\therefore\ (Kb_1)^2 + (Kb_2)^2 + (Kb_3)^2 = a_1^2 + a_2^2 + a_3^2,$$

$$K^2(b_1^2 + b_2^2 + b_3^2) = a_1^2 + a_2^2 + a_3^2,$$

$$\therefore\ K^2 = \frac{a_1^2 + a_2^2 + a_3^2}{b_1^2 + b_2^2 + b_3^2}.$$

$$\text{But, } K = \frac{a_1}{b_1}, \qquad \therefore\ K^2 = \frac{a_1^2}{b_1^2};$$

$$\therefore\ \frac{a_1^2 + a_2^2 + a_3^2}{b_1^2 + b_2^2 + b_3^2} = \frac{a_1^2}{b_1^2},$$

$$\text{That is, } a_1^2 + a_2^2 + a_3^2 : b_1^2 + b_2^2 + b_3^2 :: a_1^2 : b_1^2.$$

10. J. W. H.—If $a : b :: c : d$, show that

$$\frac{pa^2 + qab + rb^2}{la^2 + mab + nb^2} = \frac{pc^2 + qcd + rd^2}{lc^2 + mcd + nd^2}.$$

(*Todhunter's* 'Algebra for Beginners.')

$$\frac{a}{b} = \frac{c}{d}; \qquad \therefore\ \frac{pa}{b} = \frac{pc}{d};$$

$$\frac{b}{a} = \frac{d}{c}; \qquad \therefore\ \frac{rb}{a} = \frac{rd}{c};$$

$$\therefore\ \frac{pa}{b} + \frac{rb}{a} = \frac{pc}{d} + \frac{rd}{c},$$

$$\frac{pa}{b} + q + \frac{rb}{a} = \frac{pc}{d} + q + \frac{rd}{c},$$

$$\frac{pa^2 + qab + rb^2}{ab} = \frac{pc^2 + qcd + rd}{cd};$$

Similarly it can he shown that

$$\frac{la^2 + mab + nb^2}{ab} = \frac{lc^2 + mcd + nd}{cd};$$

$$\therefore\ \frac{pa^2 + qab + rb^2}{ab} \times \frac{ab}{la^2 + mab + nb^2} = \frac{pc^2 + qcd + rd^2}{cd} \times \frac{cd}{lc^2 + mcd + nd^2}$$

$$\text{Wherefore, } \frac{pa^2 + qab + rb^2}{la^2 + mab + nb^2} = \frac{pc^2 + qcd + rd^2}{lc^2 + mcd + nd^2}.$$

11. CARLOS.—Reduce the denary number of 16784 to the duodenary scale; divide 42404 by 871 in the scale of 11; and find the number in the scale of 4, which when divided by 3 gives the quotient of 133. (*Civil Service, Lower Division*, May, 1884.)

$$\begin{array}{r|l} 12 & 16784 \\ \hline 12 & 1398 \cdot 8 \\ \hline 12 & 116 \ldots 6 \\ \hline & 9 \ldots 8 \end{array}$$

$\therefore$ 16784 in the denary scale = 9868 in the duodenary scale.

$$\begin{array}{l} 871)42404(54. \quad \text{Ans.} \\ \underline{3125} \\ 3164 \\ \underline{3164} \end{array}$$

133×3 in scale of $4 = 1131$. Ans.

12. ARCY.—Solve:—

$$\frac{x}{a} + \frac{y}{b} = 2,\ x^2 + y^2 = ax + by.$$

(*Todhunter's* 'Algebra for Beginners.')

$$\left.\begin{aligned}&(1)\ \frac{x}{a} + \frac{y}{b} = 2\\ &(2)\ x^2 + y^2 = ax + by\end{aligned}\right\}$$

$$(1)\ bx + ay = 2ab$$

$$ay = 2ab - bx$$

$$\therefore\ y = \frac{2ab - bx}{a}.$$

(2) $x^2+\left(\frac{2ab-bx}{a}\right)^2=ax+b\left(\frac{2ab-bx}{a}\right)$

$x^2+\frac{4a^2b^2-4ab^2x+b^2x^2}{a^2}=ax+\frac{2ab^2-b^2x}{a}$

$a^2x^2+4a^2b^2-4ab^2x+b^2x^2=a^2x+2a^2b^2-ab^2x$

$a^2x^2+b^2x^2-a^2x+ab^2x-4ab^2x=2a^2b^2-4a^2b^2$

$(a^2+b^2)x^2-a(a^2+3b^2)x=-2a^2b^2$

$x^2-\frac{a(a^2+3b^2)x}{a^2+b^2}=-\frac{2a^2b^2}{a^2+b^2}$

$x^2-\frac{a(a^2+3b^2)x}{a^2+b^2}+\left\{\frac{a(a^2+3b^2)}{2(a^2+b^2)}\right\}^2$

$=\frac{a^2(a^4+6a^2b^2+9b^4)-8a^2b^2(a^2+b^2)}{4(a^2+b^2)^2}$

$=\frac{a^6+6a^4b^2+9a^2b^4-8a^4b^2-8a^2b^4}{4(a^2+b^2)^2}$

$=\frac{a^6-2a^4b^2+a^2b^4}{4(a^2+b^2)^2}$

$=\frac{a^2(a^4-2a^2b^2+b^4)}{4(a^2+b^2)^2}$

$x-\frac{a(a^2+3b^2)}{2(a^2+b^2)}=\pm\frac{a(a^2-b^2)}{2(a^2+b^2)}$

$x=\frac{\pm(a^3-ab^2)+(a^3+3ab^2)}{2(a^2+b^2)}$

$=\frac{2a^3+2ab^2}{2(a^2+b^2)}$, or $\frac{4ab}{2(a^2+b^2)}$

$\therefore x=a$, or $\frac{2ab^2}{a^2+b^2}$.

$y=\frac{2ab-bx}{a}$

$=\frac{2ab-ab}{a}$, or $\frac{2ab-\frac{2ab^3}{a^2+b^2}}{a}$

$=b$, or $\frac{2a^3b}{a(a^2+b^2)}$

$\therefore y=b$, or $\frac{2a^2b}{a^2+b^2}$.

13. IGNORAMUS.—Solve :—

$3yz+2zx-4xy=16$, $2yz-3zx+xy=5$, $4yz-zx-3xy=15$.

(*Todhunter's* 'Algebra for Beginners.')

(1) $3yz+2xz-4xy=16$
(2) $2yz-3xz+xy=5$
(3) $4yz-xz-3xy=15$

(1) $6yz+4xz-8xy=32$
(2) $6yz-9xz+3xy=15$

$13xz-11xy=17$ (4)

(2) $4yz-6xz+2xy=10$
(3) $4yz-xz-3xy=15$

$-5xz+5xy=-5$

$xz-xy=1$ (5)

(4) $13xz-11xy=17$
(5) $13xz-13xy=13$

$2xy=4$

$\therefore xy=2$.

(5) $xz-xy=1$

$xz-2=1$

$\therefore xz=3$.

(1) $3yz+2xz-4xy=16$

$3yz+6-8=16$

$3yz=18$

$\therefore yz=6$.

$xy\times xz=2\times 3$

$x^2yz=6$

$x^2\times 6=6$

$x^2=1$

$\therefore x=\pm 1$.

$xy=2$

$\therefore y=\pm 2$.

$xz=3$

$\therefore z=\pm 3$.

14. F. HOLTON.—Simplify $\frac{a^{-1}+a^{-1}b^{-3}}{b^{-1}+b^{-1}}$ and $\frac{2a^2+ab-b^2}{a^3+a^2b-a-b}$. (*Colenso.*)

$\frac{a^{-1}+a^{-1}b^{-3}}{b^{-1}+b^{-1}}$

$=\frac{\frac{1}{a}+\frac{1}{a}\times\frac{1}{b^3}}{b^{-1}+\frac{1}{b}}$

$=\frac{\frac{1}{a}+\frac{1}{ab^3}}{\frac{b^4-b+1}{b}}$

$=\frac{\frac{b^3+1}{ab^3}}{\frac{b^4-b+1}{b}}$

$=\frac{b^3+1}{ab^3(b^3-b+1)}$

$=\frac{(b+1)(b^2-b+1)}{ab^3(b^4-b+1)}$

$=\frac{b+1}{ab^3}$. Ans.

$\frac{2a^2+ab-b^2}{a^3+a^2b-a-b}$

$=\frac{(2a-b)(a+b)}{a^2(a+b)-(a+b)}$

$=\frac{(2a-b)(a+b)}{(a^2-1)(a+b)}$

$=\frac{2a-b}{a^2-1}$. Ans.

15. R. R. P.—In what time will a sum of money double itself at $2\frac{1}{2}$ per cent. compound interest?

(Log 1·025 = ·01072, log 2 = ·301031)

Let P denote the principal, and n the number of years;

Then, $P\left(1+\frac{2\frac{1}{2}}{100}\right)^n=2P$,

$(1+\frac{1}{40})^n=2$,

$(1\cdot025)^n=2$,

$n\log 1\cdot025=\log 2$,

$\therefore n=\frac{\log 2}{\log 1\cdot025}$

$=\frac{\cdot30103}{\cdot01072}$

$=28\frac{87}{107}$.

$\therefore$ Time = a little over 28 years.

16. C. E. K.—Prove that in taking the square root of a number when $n+1$ digits in the root have been obtained by the ordinary rule, n more may be obtained by simple division.

Ex. Find $\sqrt{2}$ to 5 places of decimals.

(The proof of the above appeared in our last issue.)

2(1·414
1
24 | 100
96
281 | 400
281
2824 | 11900
11296
2828)60400(21
5656
3840
2828
1012

$\therefore \sqrt{2}=1\cdot41421$.... Ans.

17. F. W. G.—Solve:—

$$x^{-2n} - x^{-n} = 20. \quad (\textit{Hamblin Smith.})$$

$$x^{-2n} - x^{-n} = 20$$

$$x^{-2n} - x^{-n} + (\tfrac{1}{2})^2 = 20 + \tfrac{1}{4}$$

$$= \tfrac{81}{4}$$

$$x^{-n} - \tfrac{1}{2} = \pm\tfrac{9}{2}$$

$$x^{-n} = \pm\tfrac{9}{2} + \tfrac{1}{2}$$

$$= 5, \text{ or } -4$$

$$\frac{1}{x^n} = 5, \text{ or } -4$$

$$x^n = \tfrac{1}{5}, \text{ or } -\tfrac{1}{4}$$

$$\therefore \underline{x = (\tfrac{1}{5})^{\frac{1}{n}}, \text{ or } (-\tfrac{1}{4})^{\frac{1}{n}}.}$$

Arithmetic.

1. Ver Luisant and Topical Bob.—Ash saplings after 5 years' growth are worth 1s. 3d., and increase in value 1s. 3d. each year afterwards. For their growth they require each twice as many square yards as the number of years they are intended to grow before cutting. A plantation is arranged so that each year the same number may be ready for cutting. Find the greatest annual income which can be obtained per acre, allowing 20 per cent. for expenses. (*Brook Smith.*)

At the end of 5 years gross annual income per acre

$$= (\tfrac{1}{5} \times \frac{4840}{5 \times 2} \times \tfrac{5}{4})\text{s.}$$

$$= 121\text{s.};$$

At the end of 6 years, etc. $= (\tfrac{1}{6} \times \frac{4840}{6 \times 2} \times \tfrac{6}{5})\text{s.}$

$$= 168\tfrac{1}{3}\text{s.};$$

" " 7 " $= (\tfrac{1}{7} \times \frac{4840}{7 \times 2} \times \tfrac{7}{6})\text{s.}$

$$= 185\tfrac{5}{11}\text{s.};$$

" " 8 " $= (\tfrac{1}{8} \times \frac{4840}{8 \times 2} \times 5)\text{s.}$

$$= 189\tfrac{1}{16}\text{s.};$$

" " 9 " $= (\tfrac{1}{9} \times \frac{4840}{9 \times 2} \times \tfrac{9}{4})\text{s.}$

$$= 186\tfrac{4}{11}\text{s.};$$

" " 10 " $= (\tfrac{1}{10} \times \frac{4840}{10 \times 2} \times \tfrac{5}{4})\text{s.}$

$$= 181\tfrac{1}{2}\text{s.};$$

" " 11 " $= (\tfrac{1}{11} \times \frac{4840}{11 \times 2} = \tfrac{5}{4})\text{s.}$

$$= 175\text{s.};$$

It is thus evident that the income increases up to the 8th year, and then it decreases;

∴ Annual income per acre at the end of 8 years

$$= \tfrac{1}{8} \text{ of } 189\tfrac{1}{16}\text{s.}$$

$$= \frac{\not{6}05}{\not{8} \times \not{16}}\text{s.}$$

$$= 151\tfrac{1}{4}\text{s.}$$

$$= \underline{£7\ 11\text{s.}\ 3\text{d.}} \quad \text{Ans.}$$

2. Sand Hall.—Which is the most valuable, so far as principal is concerned, £850 stock in the 3 per cents. at 93, or £817 13s. to be paid in a year's time, interest being reckoned at 3½ per cent.? What income would be derived from each? (*Hamblin Smith.*)

£ £ £
$\not{100}$: $\not{85}\not{0}$ :: 93 : Value of stock.
2 17 17

2)1581

£790½

£ £ s. £
103½ : 817 13 :: 100 : Present value of debt.
20 20
$\not{2}07\not{0}$ $\not{16}3\not{5}3$
79

$= \underline{£790.}$

∴ Stock is the most valuable.

Income from stock $= (3 \times 8\tfrac{1}{2})£$

$= \underline{£25\ 10\text{s.}};$

" " debt $= £817\ 13\text{s.} - £790$

$= \underline{£27\ 13\text{s.}}$

3. Penrith.—A woman sold 7½ dozen eggs for 6s. 2d. Some she sold at 3 for 2½d., others at 8 for 6½d. How many did she sell of each sort?

$$\text{Average selling price} = \frac{6\text{s. } 2\text{d.}}{90} = \tfrac{31}{15}\text{d.};$$

$$\text{Selling price of each in 1st lot} = \frac{2\tfrac{1}{2}\text{d.}}{3} = \tfrac{5}{6}\text{d.},$$

" " " 2nd " $= \frac{6\tfrac{1}{2}\text{d.}}{8} = \tfrac{13}{16}\text{d.};$

Difference between average price and price of those in 1st lot

$$= \tfrac{5}{6}\text{d.} - \tfrac{31}{15}\text{d.} = \frac{75 - 74}{90}\text{d.} = \tfrac{1}{90}\text{d.};$$

Difference between average price and price of those in 2nd lot

$$= \tfrac{31}{15}\text{d.} - \tfrac{13}{16}\text{d.} = \frac{592 - 585}{720}\text{d.} = \tfrac{7}{720}\text{d.};$$

∴ No. in 1st lot : No. in 2nd lot :: $\tfrac{7}{720}$d. : $\tfrac{1}{90}$d.,

:: 7 : 8;

7 + 8 = 15; 7½ dozen ÷ 15 = ½ dozen;

∴ No. in 1st lot = ½ dozen × 7 = 3½ dozen
" 2nd " = " × 8 = 4 " } Ans.

4. Ex P. T.—A quantity of wine is sold to A, at a certain loss per cent. Then A sells it to B, losing at the same rate; but B sells it to C for the original cost price, and gains thereby 44 per cent. on his outlay. What was the loss per cent. at which A and B sold the wine?

$$\text{Selling price to A} = \text{Cost price} \times \frac{100 - \text{Loss }\%}{100};$$

$$\text{Selling price to B} = \text{Cost price} \times \frac{100 - \text{Loss }\%}{100} \times \frac{100 - \text{Loss }\%}{100};$$

" " " C = Cost price $\times \frac{100 - \text{Loss }\%}{100}$

$$\times \frac{100 - \text{Loss }\%}{100} \times \tfrac{144}{100};$$

$$\therefore \text{Cost price} \times \frac{100 - \text{Loss }\%}{100} \times \frac{100 - \text{Loss }\%}{100} \times \tfrac{144}{100} = \text{Cost price},$$

$$\frac{100 - \text{Loss }\%}{100} \times \frac{100 - \text{Loss }\%}{100} \times \tfrac{144}{100} = 1,$$

$$(100 - \text{Loss }\%) \times (100 - \text{Loss }\%) = 10{,}000 \times \tfrac{25}{36},$$

$$(100 - \text{Loss }\%)^2 = \tfrac{2500}{36},$$

$$100 - \text{Loss }\% = \sqrt{\tfrac{2500}{36}}$$

$$= \tfrac{50}{6}$$

$$= 83\tfrac{1}{3},$$

$$100 - 83\tfrac{1}{3} = \text{Loss }\%.$$

$$\therefore \underline{\text{Loss }\% = 16\tfrac{2}{3}}. \quad \text{Ans.}$$

Note.—Your small hand will perhaps obtain full marks, and the other writing 85 per cent.

5. Perplexed.—If a woman by selling eggs at 16d. per doz. gain 8 per cent., how many must she sell for 10s. to gain 20 per cent.?

Selling price per egg in second case

$$= \tfrac{14}{15}\text{d.} \times \frac{100 + 20}{100 + 8}$$

$$= \left(\tfrac{7}{8} \times \frac{\not{12}0}{\not{10}8}\right)\text{d.}$$

$$= \tfrac{9}{10}\text{d.};$$

∴ No. of eggs $= 10\text{s.} \div \tfrac{9}{10}\text{d.}$

$$= \frac{\not{12}0 \times 27}{\not{9}0}$$

$$= \underline{81.} \quad \text{Ans.}$$

6. X. Y. Z.—A general contracted to pay £5454 for 13,635 pairs of boots and shoes for his army. The price of each pair of shoes was to that of each pair of boots as 5 to 8, but the number of the pairs of shoes was to the number of the pair of boots as 2 to 1. Give the number and prices respectively of the pairs of the boots and shoes. (*P. T's. Examination.*)

No. of pairs of boots $= 13{,}635 \times \frac{1}{1+2}$
$= \frac{1}{3}$ of $13{,}635 = 4545$;
,, ,, shoes $= 4545 \times 2 = 9090$.
Price of the boots $= £5454 \times \frac{8 \times 1}{(5 \times 2) + (8 \times 1)}$
$= £5454 \times \frac{8}{18}$
$= £2424$;
,, ,, shoes $= £3030$;
∴ Price of a pair of boots $= £2424 \div 4545$
$= £\frac{8}{15}$
$= 10s.\ 8d.$;
,, ,, ,, shoes $= £3030 \div 9090$
$= £\frac{1}{3}$
$= \underline{6s.\ 8d.}$

7. DUBIUM.—If money invested in the 3 per cents. give exactly £3 per cent. after paying 1s. in the £ as income-tax, find the price, allowing $\frac{1}{4}$ per cent. as brokerage. (*Cambridge Local Senior*, 1883.)

s. £ £
19 : 3 :: 1 : Percentage with income-tax.
$= \frac{3}{19}£$
$= \underline{£\frac{3}{19}}$.

£ £ £
∴ $3\frac{3}{19}$: 3 :: 100 : Price of stock with brokerage.
$= \frac{\cancel{3} \times \cancel{100} \times 19}{\cancel{19}}£$
$= \underline{£95}$.

∴ Price of stock without brokerage $= 95 - \frac{1}{4} = \underline{94\frac{1}{4}}$. Ans.

8. QUIZ.—A bicyclist ran $4\frac{1}{2}$ miles in 17 minutes. The distance made in the last minute was $\frac{1}{4}$ of that made in the first minute, and the distance made in each successive minute was less than that made in the preceding minute by the same quantity. Find the average and decrease per minute. (*Certificate Exam.*, 1883.)

Average rate per minute $= 4\frac{1}{2}$ miles $\div 17 = \underline{\frac{1}{4}\text{ mile}}$.
Decrease per minute $= \frac{1 - \frac{1}{4}}{16}$ of rate of first minute
$= \frac{3}{64}$ of rate of first minute;
Rate of first minute $= 4\frac{1}{2}$ miles $\div \frac{\text{Sum of Nos. from 40 to 24}}{40}$
$= 4\frac{1}{2}$ miles $\div \frac{544}{40}$
$= \left(\frac{17}{4} \times \frac{5}{68}\right)$ mile
$= \frac{5}{16}$ mile;
∴ Decrease per minute $= \frac{1}{80}$ of $\frac{5}{16}$ mile
$= \underline{\frac{1}{256}\text{ mile}}$.

9. M. R. S.—A gardener was handed a number of shrubs to plant in rows; he tried 10 in each row, then 12 in each, and afterwards 15 in each row, but had always 9 left. On trying 13 in each he had none left. What is the smallest number of shrubs which could have been given him? (*Civil Service Arithmetic.*)

L.C.M. of 10, 12, and 15 = 60;
∴ No. will be a multiple of 60 + 9;
The smallest multiple of 60 divided by 13 leaving a remainder of 4 is 420;
∴ Smallest No. of shrubs = 420 + 9
$= \underline{429}$. Ans.

Note.—Some letters in your writing are formed imperfectly, especially *c*, *r*, and the looped letters. Perhaps 80 per cent.

10. PUZZLED.—What sum invested in the 3 per cents. at 90 will amount to £23,112 in $23\frac{1}{2}$ years, simple interest? If the funds rose to 96, how much sooner would this sum be realised?

$£90 + (£3 \times 23\frac{1}{2}) = £90 + £70\frac{1}{2} = £160\frac{1}{2}$;

£ £ £
∴ $160\frac{1}{2}$: 23,112 :: 90 : Sum invested.
2 2
$\cancel{321}$ $\cancel{46224}$
144
$= \underline{£12{,}960}$.

In second case the amount would be realised
$\left(\frac{96 - 90}{3}\text{ or }\right)$ 2 years sooner.

11. HELPLESS.—The sum of the squares of two numbers is a square number, and the difference of their squares is a cube number. Find the two numbers. (*Cassell's Saturday Journal.*)

As the difference of the squares of the two numbers is a cube number, the two numbers have a common factor, the sum of the numbers is equal to the common factor, and the difference of the numbers is unity.
The two numbers whose difference is unity and the sum of whose squares is a square number are 3 and 4.
∴ The two numbers are $4 \times (3+4)$ and $3 \times (3+4)$
$= 4 \times 7$ and 3×7
$= \underline{28 \text{ and } 21}$. Ans.

12. SARCOPHAGUS.—An agent has to receive a rent paid in corn from a tenant, and deliver it to the landlord. At each payment he uses, so as to benefit himself, a false balance, such that 9 lbs. in one scale balances 10 lbs. in the other. Corn being worth 49s. a quarter, the value of his plunder is £46 11s. What is the corn-rent? (*Hamblin Smith.*)

For a nominal qr. he receives from the tenant $\frac{10}{9}$ qr.;
,, ,, ,, pays to the landlord $\frac{9}{10}$ qr.;
∴ Quantity plundered $= \left(\frac{10}{9} - \frac{9}{10}\right)$ of whole
$= \left(\frac{100 - 81}{90}\right)$,,
$= \frac{19}{90}$,, ;
Quantity of plunder in qrs. $= £46\ 11s. \div 49s.$
$= 931s. \div 49s.$
$= 19$;
∴ Corn Rent $= (19 \times \frac{9}{10})$ qrs.
$= \underline{90 \text{ qrs.}}$ Ans.

13. E. H. C.—Four apples are worth as much as 5 plums, 3 pears as much as 7 apples, 8 apricots as much as 15 pears, and 5 apples sell for 2d. I wish to buy an equal number of each of the four fruits, and to spend an exact number of pence; find the least sum I can spend. (*Hamblin Smith.*)

5 plums are worth 4 apples,
∴ 1 plum is ,, $\frac{4}{5}$ apple;
3 pears are ,, 7 apples,
∴ 1 pear is ,, $\frac{7}{3}$ apple;
8 apricots are ,, 15 pears,
,, ,, ,, 35 apples,
∴ 1 apricot is ,, $\frac{35}{8}$ apples;
∴ Cost of one of each of the four fruits
= Cost of $(1 + \frac{4}{5} + \frac{7}{3} + \frac{35}{8})$ apples
= ,, $\frac{120 + 96 + 280 + 525}{120}$ apples
$= \left(\frac{1021}{\cancel{120}} \times \frac{\cancel{1}}{5}\right)$ d.
60
$= 1\frac{901}{600}$d.;
∴ Least sum = 1021d.
$= \underline{£4\ 5s.\ 1d.}$ Ans.

Note.—Thanks for solution of the other query. We understood from the correspondent that the answer was 190 qrs.

14. T. P.—From a cask of wine one-fourth is drawn off, and the cask is filled up with water; one-fourth of the mixture is then drawn off, and the cask again filled up with water; after this process has been repeated four times altogether, what fraction of the original quantity of wine will be left in the cask? How many gallons of wine will be left, if the full cask contains 128 gallons?

Quantity of wine left $= (\frac{3}{4}$ of $\frac{3}{4}$ of $\frac{3}{4}$ of $\frac{3}{4})$ of original quantity
$= \underline{\frac{81}{256}\text{ of original quantity}}$. Ans.
Quantity left $= \frac{81}{256}$ of 128 gals.
$= \underline{40\frac{1}{2}\text{ gals.}}$ Ans.

15. MERSEY.—A and B each invest a certain sum of money in a business. The sum which A invests is $\frac{3}{5}$ of that which B invests. At the end of 7 months A withdraws $\frac{1}{3}$ of his capital, and at the end of 9 months B withdraws $\frac{1}{4}$ of his. The profits at the end of the year are £132 12s.; how ought they to be divided?

A's share : B's share :: $(\frac{2}{3}\times 7)+(\frac{3}{4}$ of $\frac{3}{5}\times 5) : (1\times 9)+(\frac{3}{4}\times 3)$,
$:: \frac{14}{3}+\frac{3}{4} : 9+\frac{3}{4}$,
$:: \frac{28+15}{6} : \frac{36+9}{4}$,
$:: \frac{43}{6} : \frac{45}{4}$,
$:: 86 : 135$;

£ s.
∴ 86+135 : 86 :: 132 12 : A's share.
221 : 86 :: 2865 12s. : ,, ,
=1032s.
=£51 12s.

∴ A's share = £51 12s.,
B's ,, = £132 12s. − £51 12s.
= £81.

16. ALFRED THE GREAT.—What must be the market value of 3 per cent. stock, in order that after deducting income-tax of 5d. in the £, it may yield 3½ per cent. interest? (*Outdoor Customs' Exam. Papers.*)

s. d. £ £
19 7 : 3½ :: 1 :: Percentage with income-tax.
$=£3\frac{1}{2}\times\frac{239}{240}$
$=\left(\frac{7}{2}\times\frac{239}{240}\right)£$
$=\frac{1673}{480}£$;

£ £ £
∴ 1673/480 : 3 :: 100 : Price of stock.
$=\frac{240\times 47}{1673}£$
$=\frac{11280}{239}£$
$=£83\frac{143}{239}$.

∴ Price of stock = $83\frac{143}{239}$. Ans.

17. LUDOVICUS.—A person invests £5,460 in the 3 per cents. at 91; he sells out £2,000 stock when they have risen to 93½, and the remainder when they have fallen 85; he then invests the produce in 4½ per cents. at 102. What is the difference in his income? (*Paul's 'Modern Problems.'*)

£ £ £
91 : 5460 :: 100 : Amount of stock.
60
=£6,000.

Income in first case = 3 per cent. on £6,000 = £180.
Amount realised by sale = (£93½ × 20) + (£85 × 40)
= £1,870 + £3,400
= £5,270;

£ £ £
∴ 240 : 5270 :: 4½ : Income in second case.
3 155 2
9
3
$=\frac{423}{3}£$
$=£232\frac{1}{3}$.

∴ Difference in income = (£232⅓ − £180) increase
= £52 10s. increase. Ans.

18. SUDBURY.—On July 26th the sun rises at 4 hrs. 15 min. a.m., and sets at 7 hrs. 54 min. p.m.; what o'clock is it when the sun is due south? (*Hamblin Smith.*)

It will be due south at $\frac{(12 \text{ hrs.} - 4 \text{ hrs. } 15 \text{ min.}) + 7 \text{ hrs. } 54 \text{ min.}}{2}$ from sunrise

$=\frac{7 \text{ hrs. } 45 \text{ min.} + 7 \text{ hrs. } 54 \text{ min.}}{2}$ from sunrise

$=\frac{15 \text{ hrs. } 39 \text{ min.}}{2}$ from sunrise

=7 hrs. 49½ min. from sunrise
=4 hrs. 15 min. a.m. + 7 hrs. 49½ min.
=4½ min. past 12. Ans.

19. RHODANUS.—How many parcels of 6 lbs. and 8 lbs. each can a grocer make out of a hogshead of sugar, weighing 4 cwt. 3 qrs. 14 lbs., so as to have the same number of parcels of each sort? (*Barnard Smith.*)

No. of parcels of each sort = 4 cwt. 3 qrs. 14 lbs. ÷ (6 lbs. + 8 lbs.)
= 19½ qrs. ÷ 14 lbs.
= 39 half-qrs. ÷ ½ qr.
= 39. Ans.

20. VIOLET.—A clock and a watch together cost 35 guineas. The clock cost 19½ guineas more than the watch. Find what percentage of the whole cost the watch was worth.

Cost of watch = (35 − 19½) guineas ÷ 2
= 15½ guineas ÷ 2
= 7 3/4 guineas;

guineas £ guineas
∴ 7 : 20 :: 7¾ : Percentage.

∴ Percentage $=7\frac{3}{4}\times\frac{20}{7}$
$=\frac{31}{4}\times\frac{20}{7}$
$=\frac{155}{7}$
$=22\frac{1}{7}$. Ans.

21. J. E., B.-o.-T.—The weight of a gold 10-franc piece is 49·78 grs.; the weight of a silver 5-franc piece is 385·8 grs., of which the equivalent in pure silver is ·782 oz. Troy. If the relative value of coined gold and silver be 19·29 : 1, find the intrinsic value of a gold 10-franc piece, the intrinsic value of pure silver being 4s. 2d. per oz. Troy. (*Lower Division*, May, 1884.)

Intrinsic value of 10-franc piece
$=4\text{s. } 2\text{d.} \times \cdot 782 \times \frac{49\cdot78 \times 19\cdot29}{385\cdot8}$
24·89
10
=4s. 2d. × ·782 × 2·489
=(1·946398 × 50)d.
=97·3199d.
=8s. 1·3199d. Ans.

22. JOHN.—If 23 oxen consume 8 acres of pasture in 26 days, and 25 oxen consume 7 acres of the same in 20 days, the grass growing uniformly, how many acres of it would 33 oxen consume in 5⅔ days?

oxen oxen
(23 − No. supplied by growing grass) : (25 − No. supplied by growing grass)
days days
26 : 20
acres acres
:: 8 : 7,

∴ (23 − No. supplied by growing grass) oxen × 26 × 7
= (25 − No. supplied by growing grass) oxen × 20 × 8,
(23 − No. supplied) oxen × 91
= (25 − No. supplied) oxen × 80,
2093 oxen − 91 times No. of oxen supplied
= 2000 oxen − 80 times No. of oxen supplied,
(2093 − 2000) oxen = (91 − 80) times No. of oxen supplied,
11 times No. of oxen supplied = 93 oxen,
∴ No. of oxen supplied by growing grass = 8 4/11.

oxen oxen
∴ (23 − 8 4/11) : (33 − 8 4/11) :: 8 : Part consumed.
days : days (acres)
26 : 5⅔

1800/11 : 2720/11 :: 8 : Part consumed.
26 : 17/3

$=\frac{26\times 7\times 3}{1800\times 11\times 17}$ acres.
$=\frac{3}{170}$ acres.

=3 acres. Ans.

23. SPES.—An up-train 88 yds. long, travelling at the rate of 35 miles an hour, meets a down-train 88 yds. long at 12 o'clock, and passes it in six seconds. At 15 minutes and 3 seconds past 12 the up-train meets a second down-train 132 yds. long, and passes it also in 6 seconds. At what time will the second down-train run into the first? (*Barnard Smith's* 'Examination Questions in Arithmetic.')

Distance between the two down-trains at 12 o'clock

$$= \{(88+132) \text{ yds.} \times \frac{15 \text{ mins. } 3 \text{ sec.}}{6 \text{ sec.}}\} - 88 \text{ yds.}$$
$$= (220 \text{ yds.} \times 2\tfrac{1}{2}\tfrac{1}{2}) - 88 \text{ yds.}$$
$$= 33{,}110 \text{ yds.} - 88 \text{ yds.}$$
$$= 33{,}022 \text{ yds.};$$

Gain by second down-train in 6 sec. $= (132 - 88)$ yds. $= 44$ yds.;

$$\therefore \text{ The collision will occur at } \frac{33022 \times 3}{44} \text{ sec. past 12}$$
$$= 4{,}503 \text{ sec. past 12}$$
$$= 1 \text{ hr. } 15 \text{ min. } 3 \text{ sec. past 12}$$
$$= \underline{15 \text{ min. } 3 \text{ sec. past 1.}}$$

Mensuration.

1. DERWENT.—The cost of carpeting a room 12 feet high at 6s. 8d. per square yard is £15, and the cost of painting two-thirds of the area of the walls at 10d. per square foot is £28; find the length and breadth of the room. (*Certificate Exam.*, 1883.)

$$\text{Area of floor} = \frac{£15}{6\text{s. } 8\text{d.}} \text{ sq. yds.}$$
$$= 45 \text{ sq. yds.};$$
$$\text{,, walls} = \left(\frac{£28}{10\text{d.}} \times \tfrac{4}{9}\right) \text{ sq. ft.}$$
$$= \frac{28 \times 4 \times 9}{9} \text{ sq. yds.}$$
$$= 112 \text{ sq. yds.};$$

Area of walls = Perimeter of room × Height;

$\therefore$ Perimeter of room in yds. × 4 yds = 112 sq. yds.,
Perimeter of room = 28 yds.;
$\therefore$ Length + Breadth = 14 yds.,
Breadth = 14 yds. − Length;
Length × Breadth = 45 sq. yds.,
Length (14 yds. − Length) = 45 sq. yds.,
14 times Length in yds. − (Length in yds.)^2 = 45,
(Length in yds.)^2 − 14 times Length in yds. = −45,
(Length in yds.)^2 − 14 times Length in yds. + (7)^2 = −45 + 49
= 4
Length in yds. − 7 = ±2
$\therefore$ Length in yds. = ±2 + 7
$= \underline{9, \text{ or } 5.}$

$\therefore$ Length of room = 9 yds.,
Breadth ,, = 5 yds.

2. KINDNESS.—The edges of a rectangular chest, which contains 64 cubic ft., are in the proportion of 1, 2, 4; find the actual length of its edges. (*Barnard Smith.*)

Depth × Breadth × Length = Cubical content;
$\therefore$ Depth × Twice Depth × 4 times Depth = 64 cub. ft,
8 times Depth^3 = 64 cub. ft.,
Depth^3 = 8 cub. ft.
$\therefore$ Depth = 2 ft.;
Breadth = 4 ft.,
Length = 8 ft.

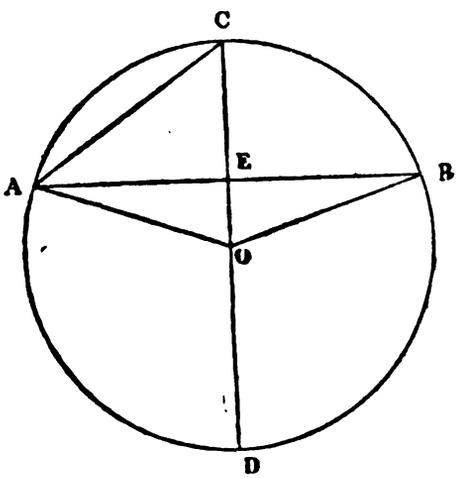
3. CECILIA.—A room is 20 ft. long and 16 ft. wide; how high must it be so that the area of the floor and ceiling together may be equal to that of the 4 walls?

Perimeter of the room × Height = Area of floor + Area of ceiling;
$\therefore$ (20 + 16) ft. × 2 × Height = (20 ft. × 16 ft.) × 2
72 ft. × Height = 640 sq. ft.
$\therefore$ Height $= \frac{640 \text{ sq. ft.}}{72 \text{ ft.}}$
$= \frac{80}{9}$ ft.
$= \underline{8\frac{8}{9} \text{ ft.}}$ Ans.

4. G. J. HOWELL.—The sides of a rectangular field of 15 acres are as 1 : 3. What are the breadth and length?

Breadth × length = area;
$\therefore$ Breadth × 3 times breadth = 15 acres,
3 times breadth^2 = (15 × 4840) sq. yds.
Breadth^2 = 24,200 sq. yds.,
$\therefore$ Breadth $= \sqrt{24{,}200 \text{ sq. yds.}}$
$= \sqrt{12{,}100 \times 2}$ yds.
$= 110\sqrt{2}$ yds.;
Length $= \underline{330\sqrt{2} \text{ yds.}}$

5. T. D.—What is the area of the segment of a circle, the chord of the whole arc being 60 feet, and the chord of half the arc 37·5 feet? (*Nesbit.*)



$$CE^2 = AC^2 - AE^2$$
$$= 37{\cdot}5^2 - 30^2$$
$$= 1406{\cdot}25 - 900$$
$$= 506{\cdot}25;$$
$$\therefore CE = \sqrt{506{\cdot}25}$$
$$= \underline{22{\cdot}5}$$

CE × ED = AE × EB (III. 35.);
$\therefore$ 22·5 × ED = 30^2
= 900
$\therefore$ ED = 900 ÷ 22·5
= 40;
CD = CE + ED
= 22·5 + 40
= 62·5;
$\therefore$ Radius = 31·25.

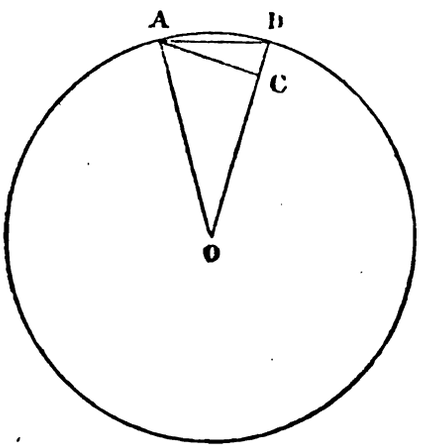
$$\text{Length of arc AB} = \frac{8AC - AB}{3}$$
$$= \frac{(37{\cdot}5 \times 8) - 60}{3}$$
$$= \frac{300 - 60}{3}$$
$$= \tfrac{240}{3}$$
$$= \underline{80};$$

$$\text{Area of sector} = \frac{\text{Length of arc} \times \text{Radius}}{2}$$
$$= \frac{80 \times 31{\cdot}25}{2}$$
$$= 1{,}250;$$

Area of triangle AOB = AE × EO
= 30 × (CO − CE)
= 30 × (31·25 − 22·5)
= 30 × 8·75
= 262·5;
$\therefore$ Area of segment = (1,250 − 262·5) sq. ft.
$= \underline{987\frac{1}{2} \text{ sq. ft.}}$ Ans.

6. YELLSERP.—The radius of a circle is 10 feet; the angle of the sector is 30°; find the area of the segment. (*Todhunter.*)

Area of sector $= \frac{30^\circ}{360^\circ} \times 10^2 \times 3{\cdot}1416$
$= \frac{1}{12}$ of $314{\cdot}16$
$= 26{\cdot}18.$



Angle ACO is a right angle, and the angle AOC = 30°,
∴ Angle OAC = 60° (I. 32.)
∴ Triangle AOC is half an equilateral triangle, and
$AC = \frac{1}{2} AO = 5$;
Area of triangle $AOC = \frac{OB \times AC}{2}$
$= \frac{10 \times 5}{2}$
$= 25$;
∴ Area of segment $= (26{\cdot}18 - 25)$ sq. ft.
$= 1{\cdot}18$ sq. ft. Ans.

General.

1. BOS.—Your query was solved in our issue for July, 1883.

2. J. W.—You will find the solution of your query in our issue for May, 1882.

3. WILL-O'-TH'-WISP.—The solution of your query appeared in our last issue.

4. BOS.—You will find the solution of your query in our issue for May, 1882.

5. NORMAL.—The writing is judged by competent authorities. We know of no book to help you in the matter.

6. S. ALLSOPP.—If you will kindly comply with Rule 2 of the Query Column, we shall have pleasure in replying to your query.

7. W. A. WOOD.—You will find the working correct by substituting $10a^2$ for $18a^2$, and adding 36×4 to 99. It is simply a clerical error.

8. PATRIA.—Write to Rev. Canon Cromwell, St. Mark's College, Chelsea, S.W., and ask for the desired information. Thanks for correction.

9. W. ASHBY.—(1) and (2) Yes. (4) All depends upon the interpretation of the wording.

10. VERITAS.—248-9. Cousin, I bid you farewell: since I am not allowed to remain near you, do not forget to inform me by letter where you are.

254-6. My grief is so great, that when I ought to have most to say, I can hardly speak a word to you.

265-6. Think of the time you are compelled to spend in banishment only as something which will render more bright and pleasant your return to England.

11. FIDUS ACHATES.—The solution of your query appeared in our issue for June, 1882.

12. RIDLEY.—(1) Yes. (2) Note the question. It asks for the origin. All authorities agree in saying 'ess' is derived from Latin 'ix' through the French.

Sentence.	Kind of Sentence.	Conn.	Subject.	Predicate.	Object.	Exten.
(*a*) How reverend is the face of this tall pile—looking tranquility.	Principal Sentence.		The face of this tall pile—looking tranquility.	is how reverend		
(*b*) Whose ancient pillars rear their marble heads to bear aloft its arched and ponderous roof by its own weight made steadfast and unmovable.	Adj. Sent. to *a*.	*In rel.*	Whose ancient pillars	rear	their lofty heads	to bear aloft its arched and ponderous roof, made steadfast and unmovable by its own weight (*purpose*).

How—adv. of degree, qual. *reverend*. Derived from A.S. *hwæt*.
whose—pers. pro., poss. case, gov. by *pillars*; from A.S. *hwa*.
ancient—adj. of quality, qual. *pillars*; from F. *ancien*, L. *ante*.
their—pers. pro., poss. case, gov. by *heads*; is almost the same form as in O.E. *thára*. It was the poss. of the A.S. demonstrative pronoun.
heads—com. noun, plur., obj., gov. by *rear*; from A.S. *heafod*.
to bear—verb, reg., trans., act., inf., gov. by *rear*; from A.S. *beran*.
aloft—adv. of place, qual. *to bear*; formed of A.S. prefix *a*, and *lyft*, the air.
weight—abs. noun, neut., sing., obj., gov. by *by*; A.S. *wegan*, to weigh, noun form, *wiht*.
steadfast—adj. of quality, qual. *roof*; from A.S. *stede*, and *faest*, fixed.
looking—pres. part. of *to look*, referring to *pile*, used absolutely; A.S. *locian*.
tranquillity—abs. noun, obj., gov. by *looking*. From Latin *trans* and *quiesco*.

13. ST. HELENA.—*Elsom's* 'Kingston Working Set of Arithmetical Cards' and the 'Adaptable' Test Cards will, no doubt, suit you. Both series can be obtained through any bookseller, or direct from J. Marshall and Co., 42, Paternoster Row.

14. OWL.—*Save*—cop. conj., joining the sentences 'All the air a solemn stillness holds' and '*It be*' understood; *that*—cop. conj., joining the sentences 'It be' and 'The moping owl,' etc.

The construction is:—All the air a solemn stillness holds, save *it be* that the moping owl, etc.

Analyse as follows:—*Princ. sent.*: All the air a solemn stillness holds. *Adv. sent. of cause* (condition): It be. *Noun sent.*: That the moping owl, etc.

In analysis some would call *save that* a single connective. It would then be:—Princ. sent. as above, and 'save that the moping owl,' etc., an adv. sent. of cause (condition).

15. SCIENCE.—If your choice lies between chemistry and electricity we should recommend you to take chemistry, as some knowledge of it is indispensable for profitable study of many other subjects.

16. LEO.—'Calm' in the line, 'His broad wings lay calm and motionless,' is an adjective. It would be wrong to call it an adverb.

17. CONGLETON.—85.

18. C. E. K.—90. All very good. For the last query see present number of THE PRACTICAL TEACHER, page 402.

19. E. D. DAVIES.—Cannot tell you of the dictionary you want.

20. ARIOVISTUS.—The passage is too long. *Abbot's* 'Via Latina,' or '*Dr. W. Smith's* 'Principia Latina,' Parts I. and IV., and *Bradley's* 'Exercises.' You want a good grammar and dictionary. You could try *White's* or *Smith's* 'Latin Dictionary,' and *Smith's* or *Roby's* 'Latin Grammar' (small edition).

21. EIDRAH.—*Todhunter's* 'Algebra' contains what you want for Annuities. Any good arithmetic would be sufficient. For the history use *Green's* 'History of the English People,' and *Bright's* 'Constitutional History.' For the literature read *Morley's* 'First Sketch of English Literature.'

22. HOPEFUL.—You don't say what examination you wish to prepare for: there are four examinations for certificates. To pass any of them you should know more than you can get from books. You may, however, get a good deal of help from *Fitch's* 'Lecture on Education,' *Bain's* 'Education as a Science,' *Spencer's* 'Education—Intellectual, Moral, and Physical. Writing 60.

23. ANXIOUS ONE.—'Mensuration for Beginners' (*Todhunter*). *Morley's* 'First Sketch of English Literature' would, no doubt, be what you want, but does not quite answer to your query. The writing is very bad. Get a few good copy-books to have it valued, and write for twenty minutes every day, and in three months let us see the result.

24. VÆ VICTIS.—You are bound to take the Greek at the intermediate examination. Hence you would not be wasting time to begin with German. The Dublin degree is considered to be easier than the London; if it is so, you would not think it as valuable. You had better write to the registrar and get the syllabus for each and compare them.

25. JACOBUS.—No. Add *Abbot's* 'Via Latina,' 'Latin Prose through English Idiom' by the same author. For French, consult *Fasnacht's* 'Series' (published by Macmillan and Co.), and *Brachet's* 'Historical Grammar.' For algebra, use *Todhunter's* 'Algebra' (7s. 6d.). For the grammar, geography, and history, special books cannot be recommended, as you have not specified which certificate examination you refer to. For general purposes you would do well to study the grammars of Morris, Mason, and Smith. 'The Student's Hume' and *Green's* 'History' are both excellent.

26. RASEN.—Large hand, 80; small hand, 85.

27. MACBETH.—First specimen, large hand, 65; small hand, 70. Second specimen, large hand, 60; small hand, 75. The large hand has many faults. Get a good copy-book.

28. DISPUTANT.—Usage has decided that we should say 'Jones was hanged,' not 'hung.'

29. ATTILA.—The gerund is a verbal substantive, having four cases, and governing the same case as the verb it is derived from; examples:—

Ars scribendi difficilis est
Aqua nitrosa utilis est bibendo
Puer paratus est ad scribendum
Puer fatigatus est scribendo.

There are two supines, one in -u, and one in -um. The first is used after certain adjectives signifying fitness or unfitness, good or evil, as

Nefas est dictu
Amarum est gustatu.

The second is used after verbs of motion without a preposition, as 'Venit lusum.'

30. SOLICITOR.—Read the Code, Article 57, 2. You can sit if you have had a favourable report upon your teaching.

31. ARITHMETIC.—We advise you to try *Nelson's* 'Royal Series.'

32. YULE.—You must have been employed more than two years as a provisionally certificated teacher, Code, Article 57, 1.

ANSWERS TO ARITHMETICAL QUESTIONS IN THE 'SCHOLAR' FOR NOVEMBER, 1884.

STANDARD III.

A. 1. 3534+19.
2. 16502+36.
3. 3008+56.
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2. 2785+39.
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D. 1. £90,900 8s. 1⅔d.
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2. 40,789 grs.
3. 402 mls. 1 fur. 19 po. ½ yd. (=1 ft. 6 in.)
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2. £1 5s. 1½d.+412.
3. £235 10s.
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2. 36,951,552 inches.
3. £255 7s. 4½d.
F. 1. £89 8s. 9d.
2. £958 7s. 8d.
3. £35 3s. 9½d.

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2. £3708 15s.
3. £11,747 9s. 2½d.
B. 1. £6 5s. 1⅔d.
2. £324 15s.
3. £65 14s. 4⅔d.
C. 1. 7 mls.
2. 38 yds. 1 qr.
3. 15 days.
D. 1. $1\frac{11}{12}$.
2. $\frac{1}{2}\frac{1}{3}$.
3. $1\frac{1}{2}\frac{1}{3}$.
E. 1. £83 14s. 7½d.
2. £128 8s. 5½d.
3. £4 1s. 9⅔d.
F. 1. 80 dozen.
2. 16,436 galls.
3. £21 10s.

STANDARD VI.

A. 1. $\frac{1}{2}$.
2. $74\frac{37}{125}$.
3. $\frac{1}{2}\frac{1}{3}\frac{1}{4}\frac{2}{5}$.
B. 1. $\frac{5}{7}\frac{2}{8}\frac{3}{9}\frac{0}{0}$.
2. ·0042.
3. $\frac{3}{5}$.
C. 1. £1 5s. $7\frac{1}{11}$d.
2. £4 17s. $7\frac{7}{11}$d.
3. ·018...
D. 1. 8 lbs.
2. $17\frac{1}{2}$ mls.
3. 16 hrs.
E. 1. £15 4s.
2. $1\frac{1}{10}$; $\frac{33}{100}$.
3. 4320 times.

STANDARD VII.

A. 1. $\frac{7}{11}$.
2. 5 p.c.; $7\frac{1}{2}$ p.c.; $3\frac{1}{2}$ p.c.
3. £87 16s. $1\frac{7}{11}$d.
B. 1. £6479 3s. 4d.
2. $7\frac{1}{2}$ p.c.
3. £52,166 13s. 4d.
C. 1. £50 14s $2\frac{1}{2}$d.
2. 50.
3. 10s.; 20 p.c.

Publications Reviewed.

SOME GERMAN INSTRUCTION BOOKS.

'OF making books there is no end,' is the quotation that most readily occurs to the reviewer with half a dozen educational works on German lying before him. However, he remembers that 'in the multitude of counsellors there wanteth not wisdom,' and certainly in those books now to be considered there is not a little that is suggestive and excellent.

One of these days, foreign languages will be taught as children learn their own, and grammar will be learnt, as morals are best learnt—not by precept, but by example. Instead of the inculcation of rules, there will be the acquisition of principles, by the reading of books in the tongue to be studied. The best teachers are already adopting the plan of at once introducing their pupils to a standard work of some standard author, and commencing upon that. This is far better than beginning on a

grammar, no matter how good the exercises may be. The difference is as that between the actual observation of facts and experiments, and the looking at diagrams.

When the 'one of these days' foretold above dawns, some instructor will reduce to book form the *viva voce* method of teaching. But the time is not yet, although that the time draws near, is shown by the nature of one of the books with which we now deal.

An Elementary German Grammar and Reading Book. By Ferdinand Schmidt, Ph.D. Trübner and Co.

Dr. Schmidt has evidently in mind the principle upon which we have insisted above. But he does not carry it out completely in practice. He begins well. Thus, in distinctive type, we find in his preface:—'In the author's opinion, the method of learning a language from books must resemble the way in which we learn it in life.' But he falls away, as we think, from his former high estate later on. Nay, even in this same preface is evidence of the difficulty of carrying out consistently an excellent idea. The last paragraph of the preface contains directions as to the order in which the sections of the work are to be studied. We are to begin with sections 1, 2, 3, 4, 5. So far, good. But then we are to take not 6 but 15, and only a fragment of that; then to jump on to 17, to read next one of the stories at the end of the book, and then presumably, though no directions are given, to return to the neglected sections from 6 onwards. It is clear that Dr. Schmidt is not the 'one of these days' man mentioned above. If a certain order is to be followed by a beginner in any subject, that order should be followed by the text-book he is to use.

Here and there are little slips in English. 'An *u*' instead of 'a *u*,' helps to perpetuate the old blunder of mistaking a sign for a thing, and regarding '*u*,' because it generally represents a vowel-sound, as always requiring the precedent 'an.' Nobody would think of writing 'an youth.' But to write, as many do, 'an university,' or, as Dr. Schmidt writes, 'an *u*,' is as incorrect. 'From thence,' p. 37, is another slip.

Putting on one side the fundamental mistake, as it seems to us, of placing the grammar rules and the reading book apart from each other, this work is good. The strong, weak, and mixed declensions are retained—an interesting fact, when we consider the uncertainty among grammarians as to the best way of dealing with that Hydra, the German substantive. The description of the verb (p. 39), given even before *sein* or *haben* is conjugated, is especially to be commended. That *bête noir* of the ordinary teacher, the so-called 'inseparable verbs,' Dr. Schmidt manages well. He avoids the nomenclatural blunder implied in the name just given, and carefully speaks of the prefixes only, as separable or inseparable. Another good practical point is the printing of the stories for reading alternately in English and in German characters. The list of strong verbs, without which no well-regulated grammar is complete, comes in at the end. The only regret we have is that the declensions, conjugations, rules, and so forth, are not worked in with the readings in the book, as they would be in teaching, if the teacher were able.

The other instruction books under our consideration are in no case, even as far as intention is concerned, on the lines of the new method. Four of them are from one pen.

A German Preparatory Course. German Method, German Conversational Questions, Child's First German Course. By Edward Schinzel. Williams and Norgate.

Mr. Schinzel certainly knows the uses of advertisement. Every one of his four books skilfully advertises the other three, and one of them has, quite like Mr. Augustus Harris, of Drury Lane, a testimonial from a clergyman. The author, by his method of printing words and paradigms, half in German, half in English characters, in the earlier pages of two of his books—the Preparatory Course, and the Child's First German Course—shows that he recognises the tendency to abolish the distinctive German characters. By his speedy reversion, however, to the German type only, he does little towards the furthering of that tendency.

The Preparatory Course starts with *sein*, goes on with fragments on the noun, and then makes a sudden rush into the comparison of adjectives. We doubt the wisdom of this last step. The declension of the adjective should, we think, precede its comparison. The statement that the adjective, when used predicatively, is not inflected, should, we are sure, precede both the declension and comparison. And for this reason. In the learning of languages, as in the learning of natural science, the mind longs for what we may call 'resting-places,' *i.e.*, generalisations of simple, trouble-saving order. Thus, if a beginner is shown that certain parts of speech are indeclinable, and will give him no further trouble than that of acquiring their meaning, he has at once gained something on which his mind can rest. In like fashion much is gained by telling the student of German, at the very earliest opportunity, that feminine nouns do not alter in the singular number. This welcome fact is not brought out in the Preparatory Course until p. 46, and is not even there made as clear as it might be. And the equally welcome fact that when used as a predicate the adjective is invariable, makes its first appearance on p. 26, at least fourteen pages too late. The only other fault of moment we can find with a book that is on the whole well-arranged, and ought to be useful in the hands of a good teacher, is as to the treatment of the conjunctions on p. 92. It would have been better, we think, to have distinguished at once, and in the text, between the two kinds of conjunction, and not to have referred to the co-ordinate conjunctions in a note, as if they were a grammatical after-thought. The English is at times a little loose—page 9, line 21; page 49, line 6 from end, to wit.

The German Method is on the same lines as the Course. In its use of brackets, initials, numbers, and various signs, it quite recalls Arnold's Latin Prose Composition in the good old days.

The Conversational Questions is the most useful of the quartette. Of course, it is open to the commonplace objection that a teacher who would need to use it ought not to be a teacher. But as, unhappily, there are many who would come under this description, the book should have its day. The questions are distinctly better than the time-honoured ones, as to the 'cat of my grandmother,' or the 'cheese of the joiner.' They are on real matters of fact, and of daily life. They are, if we may use the word, human, and not of the ghoulish kind, long familiarity with which in ancient grammars has bred a contempt not unmixed with horror.

The Child's First German Course ought to be at the mouth of its mother and its nurse. But assuming that this—the only natural method of teaching a child—is impracticable, this little book may serve. Grammatical rules ought to be excluded altogether in the beginning, thinks Mr. Schinzel, and although he need hardly have carried this excellent principle to the length of committing an error in grammatical construction two sentences before he enunciates the idea, he has carefully and consistently carried it out in this little volume.

German Grammar. By Clemens Schlomka, M.A., Ph.D. Maclehose and Sons, publishers to Glasgow University.

In one volume Dr. Schlomka does what Mr. Schinzel does in four, and he does it better. This is, in all respects, the best work of the six under review. We are not sure that we ought not to say it is the best of all the German grammars (and their name is legion) that we have seen. The order of succession, although to some of the old school it may appear confusing, is, in reality, philosophical. It is the outcome of a mind not only acquainted with English and German, but with human nature. With conspicuous wisdom, the gruesome rules

for pronunciation of every possible combination of letters that dishearten beginners are omitted. Only the essential facts are given. Grimm's Law is illustrated rather than formulated. At page 13 its principle is ingeniously worked in, and on page 65 similar wisdom is shown by the interpolation between *haben* and *sein* of some hints on the subjunctive and word-order. The explanation of the use of *lassen* (p. 197) is another example of the fresh thoroughness of the work, though we are half sorry that the equally excellent explanation of the use of the German active infinitive for our passive form of the verb 'to be' is not completed by the pointing out that we have in English a remnant of this construction. We say, 'This house to let,' or 'This house to be let' indifferently. Whilst '*Dieses Haus zu vermiethen*' would be the sense-equivalent of both phrases, it is the verbal equivalent also of the former. Dr. Schlomka's method with the noun and verb is far simpler than that in general use. He rejects, as to the noun, all the multitudinous declensions, lays at the outset stress on the two key-cases, the genitive singular and nominative plural, works in at once the invariability of the feminine singular, and then deals with the singular number only, and later with the plural alone. As to this last, he states frankly that the nominative plural is better learnt from a dictionary than from a grammar, and he is consistent enough to print the nominative plural after the singular nominative right through his work, whenever there is likely to be the least difficulty. The only suggestion we can make in respect to the eighteen lessons devoted to the noun is that Lesson 28, on proper names, should come after Lesson 24, *i.e.*, before the study of prepositions, or, yet better, after Lesson 12, *i.e.*, between the study of the singular and the plural of substantives. The irregular verbs are grouped into twelve sets, dependent on the root-vowel modification that occurs in the principal tenses. We are inclined to join issue with Dr. Schlomka on his use of the word 'irregular.' He points out, on p. 185, that the word is an erroneous one, and that 'ancient' would be better. But as the words 'regular' and 'irregular' are used in other languages and in other grammars, he yields to the pressure of custom. The question is, whether a larger principle is not involved—that of accuracy, not only of word, but of thought. It is a question, however, too large for discussion here and now. The separable and inseparable verbs turn up again, and we would suggest to Dr. Schlomka whether he may not follow Ferdinand Schmidt's good example here, and get rid of these inaccurate names. A tabulated arrangement of the verbs would make yet more useful a book that is singularly able and complete.

Shakespeare's Henry VIII. With Notes, Examination Papers, and Plan of Preparation. London and Edinburgh: W. and R. Chambers.

'To what base uses we may return, Horatio!' Why may not imagination trace the noble work of Shakespeare till he find it made an examination subject? It is, alas! 'not to consider too curiously.' For the little book before us reminds us that Shakespeare is, like many other less excellent things, given over to the examination-Minotaur. As long as the examination fever affects our educationists, and even the public, in the main indifferent on these questions, so long, we suppose, Shakespeare must be put to this not very noble use. We are only too glad, moreover, that as early as possible our children should be brought face to face with the master. But it should be 'face to face.' They should, as we think, read him at first without note or comment, just as we see him enacted at the theatre. As it is, now-a-days, they only see him through a veil of notes and explanations, more or less accurate, that not only disguise him very carefully, but often disgust the young minds that are eager for the story and the poetry, and have a lordly carelessness as to details, philological or otherwise. The preparer of the 'Henry VIII.' seems half conscious of all this, for he has not placed his name on the title-page. He has, however, frequented, we should say, the British Museum Reading Room, and utilised Case 2,046, where the various editions of Shakespeare most do congregate. Hence we have the usual *olla podrida* of quotations from Johnson, Stevens, Pope, Holinshed, and so forth. These are as accurate and as uninteresting as ever. The notes containing these excerpts from experts, and a few explanations and paraphrases from our anonymous editor, are placed inconveniently at the end of the book. We have not read them all, but one, on p. 93, has caught our eye. The explanation of ''s death,' 'zounds,' is not full enough. If the ugly phrases are to be dealt with at all, let us deal with them accurately. The anonymous editor sacrifices precision to prudery. There are some hypothetical examination questions at the end. Their value, and in some degree that of examinations generally, may be gathered from a quotation of one of the inquiries: 'Discuss the characters (1) of Queen Katherine, (2) of Cardinal Wolsey.' This is questioning at large for schoolboys and schoolgirls.

Shakespeare's Plays for Schools. Abridged and annotated by Charlotte M. Yonge. National Society's Depository, Sanctuary, Westminster.

This book, designed especially to meet the requirements of English Schedule II., Code 1883, has as editress, Miss Charlotte M. Yonge. Her introduction to 'Henry V.' is written in polished and nervous English, and there is a summary of the play dealing briefly and succinctly with each scene. The customary list of persons represented becomes in part a genealogical table, Miss Yonge ingeniously grafting upon the Shakespearian names, extracts, so to speak, from what would have been the first column of the *Times* of the year 1415. Miss Yonge's notes have a more appropriate habitation than those of our anonymous editor in the book just noticed. They are placed at the bottom of each page of the letterpress, and are far more original, and not less explanatory than those already considered. In Miss Yonge's 'Henry V.,' however, as in the anonymous one's 'Henry VIII.,' there are no notes upon the thought and the dramatic construction of the play, points of far more interest and importance than chronologies and relationships, points also upon which young students most of all need guidance.

Robinson Crusoe. By Daniel Defoe. Edited for School Use, with Supplementary Notes, etc., by Alfonzo Gardiner. W. and R. Chambers.

In these days of artistic nursery books, Kinder-garten toys, and such school books as we have here, one almost regrets that one was not born later. Whether all these luxurious aids to training will result in a stronger and better generation of men and women, time alone can prove. No one can doubt that, in spite of all that may be said of undue pressure in the Board and State-aided schools, the road to learning is made now far easier than it was thirty or forty years ago. Education, as an art, has been acknowledged as such, and its professors trained for it as for any other profession. A few years ago any one who could read or translate a book from another into his native tongue, or could work questions in the ordinary rules of arithmetic or algebra, was supposed to be able to teach these subjects, and many a man can remember his master keeping his book open when he heard the Euclid class, and correcting with severity, and even punishment, such a mistake as the angle ABC for CBA. All this, we say, is past, and now, except in the very bad middle-class schools, of which we fear there are some still, teachers know how to teach and to use the fascinating aids prepared for them.

We should fancy that when 'Robinson Crusoe' is being read for the first time, the difficulty must be to keep the class' attention to the sentence being read and discussed, and, in fact, to get the children to deliver up their books at the end of the lesson.

The editor of this edition expects a great deal more than the mere reading of the text and realising of the

story. At the end of each chapter there are some very prosaic though useful exercises in word-forming and deriving. These are preceded by a glossary and short notes, giving the position of places, and even sometimes adding a little with regard to their government and history. To say that the book emanates from the firm of Messrs. Chambers, is to say that it is beautifully printed, and very attractive in appearance, and we wish the immortal, inimitable story all success in its new mission of teaching etymology.

Guides and Guards in Character-Building. By C. H. Payne, D.D., LL.D., President of the Ohio Wesleyan University, U.S.A. London: Hodder and Stoughton.

When an American divine, no matter of what denomination, is elected as a bishop or a president, we may take it for granted that he has distinguished himself as a preacher. America is essentially a land of talkers, and unless a man can talk well he can never hope to rise to the top of his profession.

Here in England men are not often appointed to high positions in the Church simply because they are good preachers; as a matter of fact, with one or two exceptions, our leading preachers are not bishops, and we have men on the bench who would never have had a chance of such advancement had their lot been cast on the other side of the Atlantic.

We open this volume of sermons, then, expecting, perhaps, a good deal more than we should, had it been prepared by an English divine; and we may say at once we are not disappointed.

The author in his preface tells us that the sermons make no claim to great literary excellence, and are published at the earnest request of some who heard them delivered and believed themselves benefited by them. With the exception of the first and last, Bible characters form the groundwork of the discourses; Joseph, Moses, Cornelius, with others, being taken as guides, and Absalom, Solomon, and Lot being amongst the guards. The sermon on St. Paul struck us as the finest. The author's admiration for the Apostle is very great, and beautifully expressed.

The book being printed from American plates we have to put up with their spelling of such words as traveler, theater, etc. The volume would make a charming and useful prize for any young man just entering life.

Shakespeare's King John. With Introduction, Notes, Examination Papers, and an Appendix of Prefixes and Terminations. By Thomas Parry, F.R.G.S. London: Longmans.

This is one of these well-known publishers' Modern Series, edited 'in accordance with the requirements of the Government Code.'

The introduction is very valuable, containing paragraphs on Shakespeare's grammar and versification; a history of the rival claims of John and his nephew, with the entire story of the play. Besides some twenty woodcuts, there is a map of the dominions of the Angevin kings. The notes are printed at the end of the book, and are just what a young pupil requires. The examination papers are arranged in two series, but are not as numerous as they might be; but the exercises on word-building are very useful. The text of the play is beautifully printed, and the volume generally is most attractive, and, considering its style, not dear, though we fear some school committees might think it too expensive to issue to their classes when so much cheaper copies can be procured.

Outlines of Mental Philosophy on the Inductive Method. By J. D. Morell, A.M., LL.D. London: W. Stewart and Co.

The author in his preface gives us a short account of the works of those who have investigated psychological questions from the basis of physiology, and he acknowledges the labours of these writers as giving him that on which he has based many of the doctrines brought forward in his work. He refers with special gratitude to the works of the German philosopher Herbart and his followers, and frankly says that 'though he has reconstructed the whole doctrine of the elaboration of ideas, their action and reaction, the method of their passing in and out of consciousness, their blending by the law of similarity, and their combination in groups and series, etc.,' that yet he feels the doctrine is due mainly to the labours of the Herbartian School, and that 'without their aid he would, in all probability, have never been able to combine the phenomena of the human mind, as they now appear, into one connected psychological system.'

The author distinctly tells us he has not pretended to enter with any detail into logical questions, and it is important that the student should realise this, or he might be disappointed at an examination in logic if depending on this work alone. We must agree with the author that if he has erred 'in the *execution* of the present handbook,' it is in having studied brevity a little too much. And we quite think with him that some may find the analyses too compressed.

The new word, 'residuum,' with, of course, its plural, 'residua,' is used by the author, and is acknowledged by him as a novel expression to embody a Herbartian idea; and this it seems to do very well.

Though the book is specially prepared with the idea of assisting candidates for the London degree; as such, it could be, and no doubt will be, immensely improved. Writers who are not accustomed to prepare, for the ordinary man, manuals with which to pass an examination, have little idea of what is required of them in this way. We are very much afraid that the ordinary university undergraduates would have great difficulty in finding the answers to many of the questions appended to the volume in the volume itself; but of that we shall speak again presently.

The subject is treated according to the principles of a natural science; in other words, as the title-page tells us, it is investigated on the *inductive method*. The author then lays down the eight points or principles on which all such investigations are based. Of these we have only room to notice one, viz., the sixth, which postulates the close connection between the different sciences, so that what is established in one science becomes afterwards data for the investigation of another. The tendency has ever been the opposite to this—to isolate mental science from the relationship it bears to other branches of inductive investigation. Mind was supposed to be so fundamentally distinct from matter, that no 'dependency could be traced between mental and physical science,' but now the author tells us, this distinction has been fully dissipated as a delusion, and it is at last acknowledged that 'mind, as the crown and summit of nature, cannot be reached as a valid branch of scientific research, except through the results of all the lower sciences.'

Every man may be almost considered as a perfect trinity—a three in one and one in three, for we find not only, as religionists would tell us, body, soul, and spirit, but, as mental philosophers tell us, a vital-force, a nerve-force, and a mind-force (including will); and these three stand in the closest correlation, the one supplying and often overtaxing the other. All this, and a great deal more, is very well worked out in the introductory chapter.

The work itself is divided into seven parts, and each part into from five to seven, and in one instance eleven chapters.

These chapters are of only six or seven pages, and being fairly complete in themselves would make a good division for regular reading and analysis.

As an appendix, there are some one hundred odd pages of examination papers, as actually set for the different examinations at London University. These papers are generally headed Logic and Psychology. Now if we turn to Part IV., 'On the Logical Processes of the Human Mind,' we only find some fifty pages on this important subject, and though no doubt they are admirably written and clearly arranged, still we doubt their being

enough, or nearly so, to enable the student to answer the questions given at the end of the book. Questions at the end of each chapter, or, at any rate, at the end of each part, would be invaluable to the student, and reference might be made, in some of the examination papers at least, to where the answers could be found.

Dr. Morell having published this volume as one of Messrs. Stewart's Educational Series, having also appended so many examination papers, and even got a 'London University graduate and experienced tutor, to eliminate from the text what would be unnecessary or confusing to the student, and to throw the whole into the form suited to the requirements of the London B.A. and other examinations, in which psychology is taken as a subject,' he must excuse us if we somewhat take exception to his work, valuable as it is, as a student's manual.

Had the volume been issued in the ordinary course, as a step forward of the Herbartian system of mental philosophy, we should have greeted it with more pleasure than we do. As such it will make its mark, but we doubt its being, from any point of view, as exceptionally valuable to the ordinary undergraduate.

The Church of England Sunday Service-Book, continuously arranged for 1885. Henry Frowde.

To quote the preface: 'The services are here given, without omission or alteration of any kind, in the precise order in which they are used in our churches, Sunday by Sunday throughout the year, so that they can be readily and intelligently followed, even by persons wholly unaccustomed to them.' This, of course, implies that morning and evening prayer are printed over and over again, the Psalms nearly twice, and other parts more than once. That there are Protestants to whom the arrangements of the English Church Prayer Book is a mystery, no one can doubt; and that many Dissenters like to attend the services of the Church on such days as their own places of meeting are shut, every clergyman knows well; but whether many will use this 'Sunday' Service-Book we doubt. If the publishers would issue separately, in the form of a very cheap manual, the entire services (including lessons), as used on such days as Christmas and Good Friday, we believe they would obtain an enormous sale for it. This volume will be of no use after 1885 until 1896, and even then the Psalms will be wrong for the first two months in the year. In 1891 the Psalms will be right, but the collects, etc., all wrong. One or two tables at the end of the book would, of course, render it perfectly usable at any time, but that, we presume, would militate against the publisher's idea of the advisability of procuring a new prayer book every year. The lessons are indicated, but not printed in full. It is suggested that the volume may save clergymen time in selecting subjects for their Sunday discourses, and were the lessons printed in full we should quite agree with this. The paper being necessarily thin, the printing is not as clear as it would otherwise be, but on the whole the appearance is attractive.

Introductory Lessons in Geography. Cassell and Co.

The early study of geography is now being made a delightful effort for the learner. He begins with observation of earth structure around him. Out of the mental images thus obtained, he elaborates by the aid of model and picture, a view of geographical facts which lie beyond the range of direct observation. Afterwards the map forms a symbolic representation of his knowledge. Just as words follow and symbolise our ideas, maps symbolise and follow the geographical facts obtained by observation. These 'introductory lessons' follow the principles enunciated above. The garden is pictured for observation, the plan follows and symbolises it. Similarly the schoolroom, the playground, and the village—all these are first presented in picture and then in plan.

The consideration of 'scale' is introduced too soon. The diagrams in the first part of the book are admirable; the cuts on pp. 55, 59, and 63, might, with advantage, be entirely omitted.

Local Examination History. Dr. Pringle. J. Heywood, Manchester.

Notes of historical events and characters are essential aids to the student who wishes easily to retain and readily to recover the facts of history. Notes are especially valuable to the pupil preparing for an examination. That this book has now reached the fifth edition is proof of the demand for such assistance as it affords. As educationists we have most faith in the value of the 'notes,' which a student of history compiles for himself; such notes will necessarily be the outcome of the pupil's thought, and the facts they register will be readily recalled, together with the events surrounding them. Dr. Pringle's notes, used within the limits suggested in his preface, will help the pupil and relieve the teacher.

Formulæ and Equations. By Rev. T. W. Openshaw, M.A. London: Bell and Sons.

This little book presents in a convenient form the most important formulæ in algebra, plane trigonometry, mensuration, and analytical conics. As stated in the preface, it is intended for teachers as a hand-book of test questions, and for students as an aid to the ready production of their mathematical knowledge. It contains a few printer's errors, mainly in the earlier part of the book, while the author uses a few symbols which may be new to his readers, *e.g.*, $n\,!$ in place of $\lfloor\underline{n}$. It is perhaps rather unwise to introduce determinants so early in the work as the section on the straight line. We can recommend the book as a useful companion the evening before the mathematical papers of either examination for the London B.A.

The New Royal Readers: Standard VI. London: T. Nelson and Sons.

This volume completes the new and admirable series of reading-books just issued by the famous Scotch house whose imprint they bear. We may at once say that the excellence of its predecessors, to which we have cheerfully borne testimony, is fully maintained in the serviceable volume before us.

It contains one of the choicest selections of standard English literature it has been our privilege to see within the compass of an ordinary school-book.

Each lesson, which is broken up into paragraphs of convenient length, is followed by a list of new words (accented), copious notes and meanings, summary, and exercises. The succinct notices of authors—such as that given of Charles Dickens on page 12—cannot be too highly praised, and should be stored in every child's memory. But the special merit of this literary reader—and the one which, in our judgment, will most commend it to inspectors as well as teachers—lies in the fact that it contains the finest scenes of Sir Walter Scott's masterpiece, 'Ivanhoe.' Our readers will know with what graphic vigour this tale has been told, when we say that the author's own words have practically been retained throughout.

Of the type, illustrations, paper, printing, and binding, it is unnecessary to speak; they are perfect. We may add that a cheap and carefully compiled series of companion Home Lesson Books may now be had from the same publishers.

An Epitome of History, Ancient, Mediæval, and Modern. By Carl Ploetz. Translated, with extensive additions, by William H. Tillinghast, Harvard College, Cambridge, U.S.A. London: Blackie and Son.

This is an English reprint of an American translation of a German educational work.

Dr. Ploetz, we are told in the preface, is well known in Germany as a veteran teacher, and author of several educational works.

In England our upper classes are generally provided with a history, and expected to get up a certain portion of it to be questioned on. In Germany such subjects are taught in the form of a lecture, the students writing as hard as they can the whole time, in order that they may reproduce the lecture or lesson in as intelligible and concise a form as possible. We have no doubt that this volume gradually grew in this way, viz., that the learned Professor worked up his notes, from which he had lectured, into their present form as a model on which his pupils ought to reproduce what they had heard. In the course of years, period after period was gone through, until the notes in the aggregate became, as they are called in Germany, an 'Epitome of Universal History.'

We are indebted, though, to the American translator for any history at all of some nations, as Japan, Parthia, and for the enlargement of other accounts, as of those of India and France.

The histories of America and England have been re-written, and thus rendered as full as that of Germany. The minuter details of the Austro-Prussian and Franco-Prussian wars have been omitted.

The index to the work is so full and well arranged that the volume becomes a short historical encyclopædia, and this renders it, to one who has read a fair amount of history, a most valuable book of reference.

As a manual for ordinary schoolboys, unsupplemented by first-rate lectures from a thoroughly-informed teacher, it would be of very little value, being naturally very difficult and uninteresting; but to a master or other, wishing to give a course of lectures on any particular period of history, we know of no better book. In fact, if references to authors were given, where details could be found, the book would be well nigh, for this purpose, perfect; yet we must, in fairness to the translator, add that in the new ground taken up by him he has given the origin of his remarks. There are several genealogical tables, drawn out in the usual way, and inserted in the text. The English publishers have not thought it right to change the spelling of words where the Americans differ from us. In its appearance the book is attractive, being well printed and strongly bound.

Sixth Reader. London: Blackie and Son.

This is the last of these publishers' series, adapted for the different standards according to the new Code. The readings vary in length, from a sonnet to an essay or description of some five or six pages. The subjects introduced are very numerous, written by authors of the last three centuries, including such names as Spenser, Addison, Herschel, Washington Irving, Dickens, and Ruskin, with many others. At the end of the book there is a list of words derived from the Latin, with another of the Latin words themselves, giving, in the case of verbs, that portion of the Latin words whence the English equivalent is formed, the simple English being inserted in brackets, thus: 'Caedo, caesum [I cut, kill]; concise, decisive, homicide, incision. In addition to these hints, there is a glossary of the more difficult words.

Considering the clear print, the strong binding, and its cheapness, it ought to demand a large sale.

PRIZE BOOKS.

MESSRS. HODDER AND STOUGHTON'S LIST.

First Notice.

THESE well-known publishers have issued, as usual, a number of prettily-bound, well-printed, and, in some instances, beautifully-illustrated volumes, to be given as prizes at the close of the current term, or as Christmas presents.

All the books before us are of a decidedly religious turn, and do a great deal more than what is generally termed point a good moral. In one instance, as will be seen below, we are almost afraid the authoress has gone too far; and we cannot but fancy she would have done better had she left much of what she has said, good and true though it be, to be read, as it were, between the lines. At the same time, we cannot but congratulate prize-givers—of whom, happily, there are so many—that they can so fearlessly distribute Messrs. Hodder's publications without examining them.

In these days of freethought one ought to be particularly on the alert as to what books fall into our children's hands, as a careless prize-giver may unwittingly do incalculable harm in presenting an attractive volume, without thoroughly examining its contents. If these volumes be, as we believe they are, fair specimens of the prizes issued from Messrs. Hodder and Stoughton's house, teachers, and parents, and present-givers generally, need, as we have said above, have no hesitation in ordering them *en masse*.

(1) The Orient Boys: a Tale of School Life.

The name of the author of this story is not given, nor are we told on the title-page that he or she (probably the latter) has published anything before. We do not require to be told that the volume is printed from American plates, for, before we have read two pages, we feel that we are, nor can be, in no English school. English boys, no doubt, will be interested to know how their New England cousins comport themselves at their schools. If this be a true sketch—as we doubt not it is—then we hear new expressions, and find lads figuring under circumstances in which they would never be found in this country. Still, there seems to be there, as here, very much the same mixture of noble boys and mean, industrious boys and idle ones, even religious boys and irreligious ones.

A hot-blooded Cuban, sent to the north to escape tropical ailments, is, perhaps, the most interesting sketch; and how he obtained mastery over himself and his fiery temper is, we think, the most useful lesson in the book. The bad boy who, directly and indirectly, does all sorts of harm, is not so interesting. Nor are there in any way indicated those slight signs of underlying goodness which, we feel sure, must have been at times apparent in one who changed as much as he is represented to have done.

There is what we might almost call quite a theatrical death-scene, which reminds one of that of Eva amidst her slaves, etc., in 'Uncle Tom's Cabin.'

The three principal characters pass from school to college; but, whilst there, interrupt their studies by joining the Northern Army during the Great Rebellion; but of their experiences as soldiers we hear very little. At the end of the war they conclude their studies, as hundreds of the young volunteers did; and we leave them married and useful.

(2) Meg's Mistake, and other Sussex Stories. By Mrs. Robert O'Reilly.

Though the bulk and price of this volume is precisely the same as the others, there is nearly twice as much matter in it, the print being smaller, though comfortably readable by even older eyes.

Mrs. O'Reilly is one of our most successful short-story writers, and every one knows how far more difficult it is to write a good short story than a longer one. We presume by putting 'Meg's Mistake' at the commencement of her volume, the authoress thought it the most worthy to lead the other stories before the world; we cannot think so. If ever these stories be published separately, we fancy others of them will be found more popular than 'Meg's Mistake.'

'Miss Olive's Boys,' for instance, is a charming sketch of thirty-five pages, as to how a nature-loving, simple-hearted squire's daughter may influence a lot of country boys with her intensity and reality. She has a class in the Sunday-school, and though she has far less to teach them than others of Biblical facts, etc., she has a very strong feeling of right and wrong, and all her lads more or less; feeling first that she cares for them to do right, and learn to try and live more as they ought to from higher motives.

The crowning story of the book is, we think, one called 'A Golden Wedding,' in which there is a wonderful old heroine, deserted and neglected, living on, confident that her old man will return to her when he wants her, which, of course, he does. The illustrations by that well-known

artist, Fred. Barnard, are wonderfully graphic, and are certainly a real addition to the book.

(3) **Just in Time; or, Howard Clarion's Rescue.** By Mrs. G. S. Reaney.

Beautiful in many ways as this book is, earnest as the direct religious teaching is, we confess we are at a loss as to what boy or girl we should wish to present it. The story opens in the nursery of a grand house, where we find a poor little boy disgracefully neglected by his pleasure-loving mother, and positively ill-treated by a deceitful nurse. His only friend seems to be a young servant who talks religion to him, and who loses her place by trying to make the mistress understand the true state of affairs in the nursery. We have in this chapter some valuable remarks about children's prayers and children's services. In the third chapter we find this poor neglected child as an undergraduate home for a vacation, being upbraided by his indignant mother for drinking too much champagne at *her* table. We then find him painting in North Wales, where he sees and falls in love with a pretty country girl of the middle class, whom he marries in haste. After this, he goes from bad to worse, deserting his wife and child, until we find him all but ruined in the hands of an unprincipled man and woman, who have him entirely in their power. Here (we will not tell how) the poor wife finds him, and succeeds in getting him home, so at the last becoming, as the title-page tells us, 'rescued, just in time.' The faithful servant of his baby days turns up again, and is found doing a good work wherever she goes. In addition to her, there is another religious servant, who plays an interesting and useful part in the story.

Now for whom, we ask, is this book suitable as a prize? For little children it would certainly be of none. Elder girls, perhaps, might learn to be careful how they allowed their young hearts to be influenced by those of whom they know but little. Young men, too, might, no doubt, be warned against the evils of drink and dissipation; but, would they read it?

At the same time, no doubt, there are very useful lessons to parents, in the higher stations of life especially, as how they firstly leave their children to unprincipled nurses and governesses, and secondly, commit their daughters' happiness to men whose position and incomes may be good, but whose morals are weak and vacillating; but such have got beyond their prize-receiving.

(4) **A Long Lane with a Turning.** By Sarah Doudney.

Like all this gifted authoress's stories, this is not only exquisitely written and true to life, but breathing with an unobtrusive religion. In the course of the book, one of the characters says to the heroine, when asked why she did not marry:—'In my young days I had to choose between Lancelot and Arthur, and I took Lancelot, as nine women out of ten would have done. And then, Mary, I had to let him go. Do you understand?' And so in fact was the experience of the heroine herself, though the speaker knew it not. She, too, had chosen Lancelot, and had to let him go. To show how beautifully the story is welded together, we find it almost impossible to refer to a single character in the book without telling more of the plot than it would be kind to do.

Miss Doudney is evidently very fond of that old fashioned, yet ever fresh allegory, the 'Pilgrim's Progress.' We hope that the allusions to it may lead some to refresh their memories with its wonderful beauties and immortal lessons.

The authoress is assisted by Miss Edwards, who furnishes some sixteen full-page engravings, drawn with her usual power.

The Try Arithmetic. For all Classes of Schools. By Dennis Heywood, C.M. John Heywood.

This book consists of a very large collection of examples, carefully arranged in sets, generally of four, sometimes of as many as seven. The work is divided into six parts, corresponding to the requirements of the different standards, and each part into four quarters—the last quarter of each part being 'Inspector's Tests,' given in the same form as received by the children, when being examined. Before the 'Inspector's Tests' come problems, where the child has to make his own statement. These sets of fours are named after the letters of the Alphabet, increasing in difficulty, so that the questions under X, Y, Z, require more careful working, or are more difficult to state, than those under the earlier letters of the Alphabet. In the higher standards, each Alphabet receives some special name, as for instance, 'Miscellaneous Examination.' This, of course, is done for easy reference—so that a teacher simply has to give out for home-work, say Standard IV., Reduction, K; or, Standard VI., Vulgar Fractions, R; or Examinations, G. The author assures us in his preface that teachers in large schools have found the book eminently useful and time-saving, and this we can well believe.

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Matriculation Hints.

By Henry A. Reatchlous, M.A. (Lond.), B.Sc.,

Westminster Training College.

The subject of heat is usually included in the manuals on Natural Philosophy. The student may refer to these, and among them to Everett's 'Text-book of Physics' (Blackie and Co., 2s.), and to a little book called 'Lectures on Heat,' by Dr. Wormell (Murby and Co., 1s.). Professor Garnett's 'Elementary Treatise on Heat,' (Bell and Sons) is a very excellent book. With the syllabus before him, the student can select the parts specially named, and devote most of his attention to them.

Notice is first drawn to the sources of heat. These are enumerated by Professor Garnett as (1) radiant energy; (2) chemical action (including combustion); (3) mechanical sources as in the case of friction and impact, etc.; (4) electrical currents; (5) change of state, as when steam is condensed into water; (6) internal heat of the earth (the last being only a source of heat previously accumulated). The next, and very important point is to distinguish clearly between temperature and heat. Temperature is the state of a body considered with reference to its power of communicating heat to other bodies (Wormell). It is a quality, not a quantity; it is estimated in degrees by instruments called thermometers. Heat is a measurable quantity, a form of energy, and is expressed in thermal units, or in the number of ergs equivalent to them. The thermal unit now most commonly used is called a calorie; it is the amount of heat required to raise the temperature of one gram of water from 0°C. to 1°C. Instruments for measuring quantities of heat are called calorimeters.

The subject of thermometers is, including the conversion of degrees from one scale to another, explained fully in the text-books. The use of a weight thermometer should be understood (Everett, page 105). If we assume the absolute expansion, we are thus able to deduce that of the glass we are using, and then, by observing the apparent expansion of any liquid, we can find its absolute expansion.

A gas expands $\frac{1}{273}$ of its volume at 0°C. for each degree centigrade. Hence, V_0 be the volume at 0°C., and a be the co-efficient of expansion, the volume at any other temperature t will be $V_0(1+at)$; and, similarly, at any other temperature, T, it would be

$V_0(1+aT)$; hence the ratio of the volumes at t and T $= \frac{V_0(1+at}{V_0(1+aT} = \frac{1+at}{1+aT}$.

This result is made use of in determining the value of a. If we know the volume of a gas at, say, 15°C., and the volume of the same mass of it at 100°C., then a can be determined from the equation $\frac{V_t}{V_T} = \frac{1+at}{1+aT}$

If we keep the volume constant while the temperature is raised, the pressure of the gas will increase, and if the pressure at temperature t and at temperature T be observed, we can determine a from the relation $\frac{P_t}{P_T} = \frac{1+at}{1+aT}$. The zero of temperature is often taken to be that at which ice melts under a pressure of 760 mm. of mercury. What is called the absolute zero of temperature is 273° below this. Hence, we can express the absolute temperature by adding 273 to the ordinary centigrade reading. Assuming T to stand for the absolute temperature, V for the volume of a given mass of gas, and P for the pressure under which it exists, $\frac{PV}{T}$ will be a constant quantity, whatever be the special values of P, V, and T. This is a neat formula for solving such questions as the following :—

(1) 20 litres of air are measured off at 15° C. and 700 mm.; what volume with they occupy at 30 C. and 760 mm.?

$$\frac{PV}{T} = \frac{P_1V_1}{T_1} \quad \therefore V_1 = \frac{PV}{T} \times \frac{T_1}{P_1} = \frac{700 \times 20 \times 303}{288 \times 760} = 19{\cdot}4$$

(2) The volume of a gas is increased by one-half, while the pressure under which it exists is increased by two-thirds, if the temperature were originally 15° C., what would it be finally?

$$\frac{PV}{T} = \frac{P_1V_1}{T_1} \quad \frac{PV}{288} = \frac{5P \times 3V \times 1}{3 \times 2 \times T_1}$$

whence $T_1 = \frac{288 \times 15}{6} = 720$ abs. $= 447°$ C.

Attention is called to specific heat, latent heat, and the instruments for determining them. The student is strongly advised to determine for himself (roughly, of course) the specific heat of a few metals. Instructions for this are given on page 79 of Dr. Wormell's Lectures. He should also find the latent heat of water and steam by the method of mixtures. To determine the latent heat of water, place a known weight of water at a known temperature into a calorimeter (which may be a small tin canister). Add fragments of ice, previously dried with blotting-paper. Observe the temperature when the ice is just melted, and then weigh, so as to determine the quantity of ice used. Suppose we had W grams of water to start with a temperature T; that we used M grams of ice, and that the final temperature was t; put x for the latent heat of water, then $WT = Mx = (W+M)t$. Several corrections must be made to get a good result: the specific capacity of calorimeter is the most important of these. But it is much better to try the experiment without corrections than omit it altogether. The method of obtaining the latent heat of steam is described in Professor Garnett's 'Elementary Treatise,' on page 102. Into a current of steam is passed a known weight of water at a known temperature, and when the temperature has risen some degrees the jet is removed. Putting x for the latent heat of steam, and using the same letters as before, we should have—

$$WT + Mx + M \times 100 = (W+M)t.$$

It is worth while to note that the latent heat of steam varies with the temperature at which it is produced. It requires 100 thermal units to raise one gram of water from 0° to 100° C., and 537 more to convert it all into vapour at 760 mm. pressure, giving a total of 637; at 90° C. the latent heat is 554, at 110 C. it is 529. The general phenomena of boiling should be carefully observed, and experiments to show the dependence of the boiling point upon the pressure devised. Small bottles can be filled with water and placed in a freezing mixture (salt and pounded ice); they will burst as the water becomes converted into ice. Melt a paraffin candle in a glass beaker, notice the great contraction upon solidification. The melting point of bodies which expand in solidifying is lowered by pressure, while it is raised for bodies which contract.

Heat can be transferred from a hotter to a colder body by conduction. Conduction of heat is always from a hotter to a colder part, and the process is always comparatively slow. The conducting power of two bars cannot be determined by the rapidity with which enough heat travels down equal lengths of them to ignite a piece of phosphorus. We must wait until the flow of heat is steady. When it is so, the number of thermal units that flow through one unit of area of a plate of unit thickness, its two sides being kept at unit difference of temperature, is called the specific thermal conductivity of the substance. Let the area of a plate be ab, its thickness c, T the temperature of one face, and S of the other, and K the conductivity; then the number of thermal units that pass through it in t seconds is $\frac{abtK}{c} \times (T-S)$.

How much heat is conduced through a plate of iron in 20 seconds of 40 cm. length, 6 cm. breadth, and ·5 thickness, the faces being kept at 90° C. and 100° C. respectively (the conductivity of iron is ·16). Ans. $= \frac{40 \times 6 \times 20 \times \cdot16 \times 10}{\cdot5}$ $= 15{,}360$ calories.

Heat can also be transferred from one body to another, from a hotter to a colder, and from a colder to a hotter, by radiation. A block of ice melts when placed near a fire; the heat it receives from the fire is greater than the heat it radiates to it. If we put different substances at equal distances from a source of radiation some will get hotter than others; they will absorb more heat. Bodies which absorb heat readily radiate it readily, lamp-black being the best radiator known.

There is no real difference between light and radiant heat. Rays which cause the sensation of light also cause a sensation of heat, but some rays which excite the sensation of warmth do not affect the sense of sight. Some bodies allow light to pass through them more or less completely; this is also true with regard to heat. Examples should be learned. Remember that the heat which is neither reflected nor transmitted by a body is absorbed by it, and raises its temperature.

When heat is applied to the bottom of a test-tube, the water immediately above it becomes warmer and specifically lighter (if not between 0° and 4° C. at the commencement), and rises. This mode of transferring heat is called convection. It is by convection that gases and liquids are generally heated. Simple experiments with coloured water to show convection currents should be practised, the explanation of winds, ventilation and ocean currents understood.

(To be continued.)

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A Monthly Educational Journal.

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The numbers of the *Practical Teacher* for February and March, 1884, are now out of print.

Gossip.

This month, in place of the usual Pupil-Teachers' Questions and Answers, we have the pleasure to present our readers with the major part of '*My Certificate Answers*,' by Mr. Arthur Day, who won the post of honour in the Borough Road Training College List. The answers are as nearly as possible those which the writer set down at the Certificate Examination. It will, doubtless, interest a large number of our correspondents to learn that, appended to the complement of the answers, which will appear in our next issue, will be found a list of the books used by Mr. Day.

***

In future, Pupil-Teachers will be examined only twice a year. Those whose school year ends from the 31st of January to the 30th of June, will 'sit' on the last Saturday in April, and the others on the last Saturday in October. This important change, while economising the time of the Inspectors, will tend to secure a greater unanimity in the *standard* of examination, and will, doubtless, encourage what is generally known as the Centre Training of Pupil-Teachers (Art. 110).

***

Instead, therefore, of having eleven examinations, there will henceforth be but two. This arrangement will, by placing considerable additional space at our disposal, enable us to introduce into our pages several most valuable subjects, which cannot fail to render our journal increasingly attractive and serviceable to students and teachers. Particulars of these new features will be announced in our next issue, and we trust our friends will kindly make known the changes as widely as possible.

Messrs. Jarrold and Sons announce a new edition of their handy 'Teacher's Diary and Pocket-Book,' which for the past two years has found, and deservedly so, much favour in the profession. Mr. A. Johnston, of 6, Paternoster Square, has recently issued a new series of Copy-Books—including a kindergarten book—which we hope to notice next month. The Messrs. Nelson have also just published the last volume in their well-known series of 'Royal Readers.'

***

Teachers on the outlook for prizes will be glad to hear that the current season promises to be an exceptionally busy one. From Messrs. Blackie and Son and Messrs. Hodder and Stoughton we have already received consignments of elegantly bound prize-books. In our next issue we shall have a special notice of them. Meanwhile, those of our readers who use prizes, and wish to know something of the coming books, cannot do better than drop a line to any of the following firms, who will gladly furnish a full descriptive catalogue of their respective publications:—

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***

We beg to remind our readers of the announcement at the foot of our title-page. The *French Lessons* which are begun in the *Scholar* for November have been prepared by an experienced teacher, and will be found most carefully graduated.

The Value of Written Reproductions.

BY EDWARD R. SHAW,

Principal High School, Yonkers, N. Y.

NOT one of all the aids to language training is of greater value than reading to a grade or class a selection, and then requiring them to reproduce it in writing. In examining courses of study from scores of town and city schools, we find a wide recognition of the value of this exercise in directions like the following: 'Writing abstracts from memory;' 'Pieces read to grade and grade required to write them out from memory,' etc.

The value of these exercises consists, in the first place, in enlarging the pupil's vocabulary, and that, too, in the most natural way, because he grasps the ideas and thoughts lying behind the words; he grasps them, moreover, in a way that he does not in reading lessons, from the fact that he is to reproduce the thought, and will naturally do so in calling up the identical words of the selection.

Further, the pupil in writing out what has been read to him, is having a most valuable exercise in spelling and punctuation.

In the reproduction the pupil is constructing sentences that are related to each other in thought, and is therefore working in keeping with the idiom of the language—the way that all command of language is gained. How different the sentences of a reproduction, connected as they are in thought, to those detached ones, mechanically made to comply with some stated requirement imposed by the teacher!

Then there is a development of the imagination in these exercises. Of course, it is what we may term the reproductive imagination that is trained, and not the creative; but the reproductive must be made active in order that the creative may develop. In these reproductions there is always food and exercise for the imagination, and this undoubtedly accounts for the pleasure experienced by pupils in doing the work.

But while so much growth in language, spelling, composition, imagination, and appreciation of style results from the exercises of which we are speaking, there is comparatively little of this written reproduction work. It is doubtless in consequence of the fact that teachers are unable to find, at their command, sufficient material for the work. The selections must possess certain qualities, without which they are of little value, and if selections lacking in these qualities are read to a class, the attempted reproduction will result in failure and discouragement both to teacher and pupils. As a first requisite, the selection must be a perfect and striking whole, and for commencement work should be largely narrative. It must be such that the pupil can easily grasp it. It must make upon his mind a forcible impression; for if it leaves only a vague impression, his working it out will be obscure and disconnected.

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THE

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'Knowledge is proud that he has learned so much,
Wisdom is humble that he knows no more.'—COWPER.

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Hygiene.

BY ALFRED CARPENTER, M.D., M.R.C.P. (LOND.),
Chairman of the Council of the Sanitary Institute.

CLOSETS—(*continued*).

There are very numerous varieties of w.c.'s. The best kinds may be seen in action at the Parkes Museum in Margaret Street, London. The simpler the construction the better. The discharge of water when the handle is raised, after the closet has been used, should be immediate, rapid, and complete, not taking more than five seconds for the whole discharge, so as to flush away the soil and leave the w.c. perfectly clean. There should be not less than two gallons of water for each flushing. The soil should be carried off directly into the sewer; there should be no chance of its retention in the neighbourhood of the closet by any faulty construction of the soil-pipe or house-drain. The Bramah valve closet is the oldest form now in use, but a w.c. is not a perfectly recent introduction, for Evelyn, in his Diary, written about 1690, mentions a w.c. as existing at Beddington House, close to the present sewage farm of the Croydon Corporation, which excited his admiration as an ingenious piece of mechanism.

The conditions which make a good w.c. are that the water seal should stand well up in the basin, the water not liable to syphonage; that the closet should be well-lighted at all times, so that the water in the basin can be seen. The basin should be flushed thoroughly clean by each discharge, by which every part of the basin and trap should be left free from foulness. If also it could be rendered available for slop discharge, so much the better. The lid attached to a closet seat is a mistake; it is wrong to shut it down, so as to cover in any smell which may be there. There should be free ventilation all around, and the w.c. which shows all its parts is so much better than one shut up in mahogany fittings, and boxed up so that foulness may be hidden away instead of being altogether prevented, and the surroundings dusted out by the chamber-maid regularly every day. It is necessary that great care be taken to ensure an adequate ventilation in the soil-pipe, so that the trap may not be destroyed by syphonage. If this protection cannot be afforded by any reason connected with situation, it is better to completely change the position of the closet so as to allow of a ventilating pipe being carried into the open air, so as to protect the trap; otherwise a pail of water, suddenly discharged, may unseal the trap and put the w.c. in direct communication with the soil-pipe. The soil-pipe should itself be ventilated by being continued straight upwards to the top of the house with a bore as large as the soil-pipe itself. It should be covered at the top by a grating or cowl, so as to prevent the stoppage of the upward current, which a bird's nest or other kind of cork might produce.

The provision as to soil-pipe ventilation must on no account be omitted. The top of this ventilator should be decidedly above the level of the windows. It should not be near to the level of a chimney or in such a situation as that its unseen smoke may find its way into the house before the gaseous material can have been oxidised and its virulence destroyed. A movement of a few yards in the open air will certainly effect this object, though it is possible that there may be a disagreeable smell. No enthetic disease will be propagated, provided the gaseous matter has been thoroughly diluted with pure air in the upper regions of the atmosphere. The minute germs of particulate matter upon which the promulgation of disease depends will be annihilated by admixture, and the change which friction will establish in its passage through the atoms of gas which make up the atmosphere. I introduced the proposal of soil-pipe ventilation at a meeting of the Social Science Association some fifteen years ago; it was decidedly sat upon by some of the *savans* then present, but it is now universally regarded as a necessity of the water-carriage system of sewerage. After it was recognised by some of our local authorities it was ignored by the race of plumbers, and in my own town it was the custom to put in a dummy ventilator, so as to comply with the bye-law; they were thought to be useless, and "Carpenter's fads" existed in a great number of instances in Croydon, until an epidemic of fever exposed the fraud to the unfortunate householder and the local authority.

In some instances it may be necessary to place a disconnecting trap between the house drain and the public sewer. These traps may be put down by in-

dividual householders for their protection against the evils which may arise from defective sewers, but they ought not to be required to be inserted by a local authority. A main sewer should never be defective, and for a local authority to allow it to remain so, and to call upon householders to put in a disconnecting trap is insanitary and not good form. If sewers were not defective there would be no necessity for disconnecting traps. The ventilation of the soil-pipe, and the entire separating of all other connections with the sewer would be amply sufficient for the protection of the householder without adding another danger to the system, for the greater the number of traps, the greater the annual expense and the greater the chance of foreign matter getting into the house drains.

A disconnecting trap requires to be protected by its own special ventilation, and is another departure from that simplicity which is always the safest and is an interference with one of the canons of sanitary science. Still, if a main sewer is known to be defective, the householder will be wise to submit to the infliction; of the two evils, it is always better to choose the least.

Earth Closets.—These can never come into common use in large towns, unless water is very scarce. The quantity used by a w.c. system is but a small addition to the total quantity required under ordinary conditions. There must be sewers for the conveyance of slop and waste water out of the place, and an addition of four or six gallons per head per day to the total quantity to be supplied by a waterworks is not very large. If there are sewers, there must be an outfall, and there is, therefore, already provided a silent highway for the conveyance of excreta to the farm, which is costless and out of sight. This is much cheaper than bringing the farm into the town and mixing it with the manure there, and then having to convey it back again to the country. Human excreta do not materially add to the offensive nature of the sewage, for, under any circumstances, the urine finds its way into the sewers; the washing of dishes and laundries, and swillings from slaughter-houses, the waste from baths, and other places of similar kind, will produce a sewage which chemically does not differ materially from that provided by a water-closetted town. But then sewers must have an abundant water-supply, which must be continuous. If a sewer is likely to be dry at frequent intervals—that is, if there is not a constant stream of sewage in it—it becomes a source of danger to the inhabitants, and ought not to be permitted. It follows, therefore, that whilst w.c.'s are the best house arrangements for town populations, they are seldom fitted for villages and sparsely-peopled districts. In these cases the earth closet becomes the necessary appendage to the home. An earth closet requires simplicity and strength of construction; there should not be any intricate mechanism by which it may be liable to get out of order, and it should be self-acting. The earth, or other deodorising material, should thoroughly cover and absorb all offensive matter as soon as the seat is left by the user. The magazine for storage of earth should have considerable capacity, so that it may not be rapidly emptied, and the pan under the seat for the reception of the excreta and its subsequent dose of earth should be almost indestructible and easily removed, at frequent and regular intervals. The action of ordinary garden mould in removing smell is well known to the country housewife. It rapidly removes the noisomeness of even cats' excreta—a shovelful of earth is fetched, and the most offensive excreta rapidly deodorised by it. There should be about one and a half pounds of dried earth for each discharge. The closet in ordinary use should be out of doors, or so placed on an outside wall that the gardener or other person employed should be able to take away the pan without having to enter the house for the purpose. This change should always be made in the early morning before the family are moving; the person changing the pan or pail should be able to see that the closet is not occupied at the moment of removal. Any one occupying a house having a quarter of an acre of garden is unwise to allow of the removal of excreta by any other means, as the gardener can always use it with great advantage, whilst, with very little trouble, he will be able to supply sufficient earth to keep the hopper of the closet properly charged. There is no difficulty if there be a garden at hand. The difficulty comes into play when the cottages of the poor are to be considered. They cannot provide earth, or always use up the contents of the pans; the landlord or the local authority must make proper arrangements for their periodical removal. There is usually some shrewd gardener or farmer in every neighbourhood who will find it to his interest to do this; and if he is not to be found, the village squire or the local authority must make arrangements for the purpose. Two pails are necessary for every closet, one to be in use, the other ready for placing when that in use is removed. There must be a store in which the unused pails may be stored. They should be properly cleansed after use and before they are put in the store-house. This should be effected by thoroughly washing them in a solution of carbolic acid or some other equally effectual disinfectant, and allowing them to dry before storing them away. The material of which the pails are constructed must not be capable of being injuriously acted upon by the disinfectant. The plan entails some annual expense, but there is not the great outlay which a sewerage system demands; there is no first charge, therefore, for capital expended, and this latter cannot be lost, as is now too often the case; because the plan of sewerage adopted has been carried out for the benefit of the engineer and not of the town. The material should be dried earth of a loamy character: sand will not do, and chalk or earth containing much calcareous or silicious matter is inadmissible. An argillaceous soil is advantageous if it is friable. Pitch pine sawdust is a very cleanly substitute, and charcoal is effectual, but it is too expensive for cottage use.

Some closets are made in which the pails have double chambers to separate the liquids from the solids. They are not so satisfactory as a pail which is supplied with a sufficient quantity of earth or sawdust that the liquid is soaked up by it. The exchange must be more or less frequent according to the number of occupants in the house. A change every day is better than one made too seldom, and it should never be left longer than four days without the exchange being made. The contents of the pails should be used up at once in agricultural or gardening operations, and not be stored, as they lose their value by keeping, and may be a source of danger if collected in bulk.

Earth closets are admirably fitted for use in sick-rooms, and are the necessary adjuncts to the hospital wards.

It is a mistake to endeavour to make any concentrated manure, such as so-called 'Poudrette,' out of the contents of earth closet pails. The sooner the excreta is mixed with a larger supply of earth and exposed to the action of vegetation the safer it is for the community and the better for the vegetable world. No germ of enthetic character can escape the decomposing action of vegetable cell-life, but the resting spores of a fever cacozyme may be wrapped up and kept for any time when preserved as poudrette, ready to spring into deadly action if opportunity should arise for developing its dangerous energy, should it find a suitable soil to increase and multiply in. The pail system finds favour in some great towns, such as Manchester, Glasgow, Leeds, and Rochdale; but it is a makeshift system: there is always a danger in the effort which a local authority may make to cut down expense by increasing receipts. The manufacture of artificial manures should only come into play as secondary actions, and never be made the primary object of a sanitary authority. When that is the case, it may happen that health is sacrificed to £ s. d., and the *raison d'être* of the authority lost sight of in the effort to save the present rate.

The plan adopted at Manchester and Glasgow is probably as free from objection as any such arrangements can be made; but the substitution of w.c's. for pails could not fail to be advantageous to the dwellers in those great towns.

Middens, privies, and cesspools ought not to be permitted to exist on any pretence: they are unnecessary, except for the purpose of providing work for the doctor and raising a death-rate.

The Scavenging of Towns.—This matter is intimately associated with the removal of refuse, and may be considered here. No town can be kept in a good sanitary state which is not regularly seweraged, and the ultimate disposal of city refuse is intimately associated with this part of the subject. If there is any plan of pail collection in a crowded locality, it must be also considered in connection with the ultimate disposal of the refuse.

The subject resolves itself into several heads: The nature of the sewerage arrangements; the disposal of the rainfall; the surface cleansing, and the ultimate disposal of collected rubbish as well as the collection of the house refuse—that is, the contents of the dust-bins—and the thousand and one articles which find a temporary resting-place in the receptacles for dust. If there is a water-closet system in general use, human excreta do not come into the calculation in the scavenging account; but in Manchester and Glasgow there is a large admixture of pail contents which have to be dealt with by the local authority, it adds materially to the difficulty of the case. There is, therefore, the removal of night soil to be considered. I must refer those interested in this question to the plans pursued in Manchester and Glasgow, at which places the most extensive works are in operation for dealing with the excreta.

The scavenging of private courts and yards must be provided for, and their sweepings carefully removed. Whilst street-sweeping is only of secondary importance to excreta removal, a city which allows its streets to be filthy, which allows heaps of refuse swept up to be scattered again before the heaps are removed, cannot be healthy.

(To be continued.)

The New Class-Subject, 'Elementary Science.'

(What to teach, and how to teach it.)

BY RICHARD BALCHIN.

To teach elementary chemistry to a class of little boys, so that the youngsters shall, at the end of the school year, be in possession of the main facts touched upon, it is, as many teachers know, absolutely necessary to be continually recapitulating. I do not mean that the *same words* should be continually repeated, for it is not my purpose to impart *words*, but rather to bring about the mental digestion of thoughts and ideas. It is thus that the reader of these notes will find the same experiment performed over and over again; each time, however, with a view of eliciting a new fact. The old experiment is repeated, and regarded from a different point of view; and at the same time an opportunity presents itself of referring to a previous lesson. For instance, the experiment showing the decomposition of the red oxide of mercury is given in Lesson II. simply to prove that this substance is a compound. It is repeated in Lesson IV. to show the precise composition of the oxide. We meet with it again in Lesson VII. to illustrate analysis and the action of heat as a chemical agent. In Lesson XX. we discuss the chief compounds of oxygen, and the experiment is repeated. I greatly prefer to fix a truth in the minds of boys in this way, than to adopt the common method of stating the fact in a neat sentence, and getting the class to repeat the words simultaneously, sometimes by the half-hour together.

LESSON VII.—ANALYSIS AND SYNTHESIS.

Elementary bodies—about sixty-six. Many hundreds of compounds of these. Some compounds contain two elements, such as water, oxide of iron, ammonia, oxide of mercury; these are like words of two letters. Write a word of two letters, such as 'on'; then by the side of it the formula of a binary compound, such as water, H_2O. Compare. Some compounds contain three elements, such as chalk; others more than three. We can separate compounds into their elements. Such an operation is called 'analysis' (Greek, *analusis*—a loosening), and means a breaking up into parts. Instance, analysis of sentences. Note at present three methods of analysis:—1st, by heat; 2nd, by electricity; 3rd, by displacement.

1st. By heat. Analyse the red oxide of mercury, note also the making of lime. Expel the oxygen from chlorate of potash.

2nd. By electricity. Describe or perform the electrical analysis of water.

3rd. By displacement. Obtain hydrogen from sulphuric acid and zinc. The metal displaces—*i.e.*, throws out of its place the hydrogen of the acid. Sodium displaces the hydrogen of water by combining with the oxygen.

LESSON VIII.—SYNTHESIS.

Compounds may be broken up into their elements, as we have seen; this is analysis. But elements combine to form compounds; this is synthesis. Burn some charcoal (carbon) in a jar of oxygen. The element carbon combines with the element oxygen to form a

compound body—carbon dioxide. Boil some mercury under a stream of oxygen—a compound—the oxide of mercury is formed. The oxygen of water combines with iron to form rust—the oxide of iron. 'Synthesis' (from Greek, *sun*, *thesis*—a placing together), means the formation or building up of compounds. Some elements more readily combine with each other than others. For instance: Place some iron nails in water. The oxygen rather than the hydrogen of the water combines with the iron. Elements which readily combine are said to have an affinity for each other. Oxygen has a great affinity for most of the other elements. Dissolve a small piece of phosphorus in bisulphide of carbon, CS_2. Pour some of the solution on a sheet of paper. The CS_2 quickly evaporates, and the finely divided phosphorus will take fire spontaneously—*i.e.*, readily unites with the oxygen of the air.

LESSON IX.—SYNTHESIS.

Elements combine to form compounds. This is synthesis. Compounds also combine to form other compounds; this is another form of synthesis. For instance, lime is a compound; it is an oxide of calcium, CaO. Limewater is this substance in solution. Carbon dioxide, CO_2, is another compound. We may combine these two. Carbon dioxide is formed —(1) by the combustion of substances containing carbon; (2) by volcanoes; (3) by animal respiration, and by fungus plants. A portion of our exhaled air is CO_2. Breathe through a glass-tube into some limewater. A synthesis takes place. The CO_2 of the breath combines with the CaO of the solution, and forms carbonate of lime, $CaCO_3$. Write this formula upon the blackboard, and note the following series of facts: (1) Some elements have combined to form a compound; what is an *element*? what is a *compound*? (2) How many elementary bodies are there in this compound? Three; viz.—calcium, carbon, and oxygen. (3) Properties of each. (4) Affinity of the O for the Ca; what this means. (5) Recapitulate facts concerning the compound CO_2.

LESSON X.—SYNTHESIS—*continued.*

Recapitulate previous examples of synthesis. Repeat the experiment with ammonia and hydrochloric acid, as described in Lesson II., *i.e.*, moisten the inside of one tumbler with strong solution of ammonia, and place a card over it; moisten the inside of another tumbler with hydrochloric acid, and invert it upon the card on the first tumbler. Both glasses are now filled respectively with the gases of ammonia and hydrochloric acid. Gently draw the card from between the glasses; the gases combine and form white fumes of chloride of ammonia.

$$NH_3 + HCl = NH_4Cl.$$

Briefly describe the various elementary bodies forming these compounds, viz., hydrogen, nitrogen, and chlorine. Also briefly describe the nature of ammonia. Its presence in the air is due, 1st, to the decay of animal and vegetable substances; 2nd, to the decomposition of the aqueous vapour in the atmosphere, through the agency of electrical discharges, *i.e.*, lightning. Thus:—

$$(4N + O) + H_2O = NH_3 + NO_2.$$

That is to say, the electrical analysis of water (H_2O) in the atmosphere ($4N + O$) results in the formation of ammonia (NH_3) and ozone (NO_2). Having performed the experiment showing the synthesis of the gases of ammonia and hydrochloric acid, explain the same by an equation thus:—

$$NH_3 + HCl = NH_4Cl.$$

The resulting compound is chloride of ammonia or sal-ammoniac (*i.e.*, ammoniacal salt). The white fumes are really countless little crystals of the salt. These may be viewed under a microscope.

LESSON XI.—THE CHEMISTRY OF THE AIR.

Repeat the experiment described in Lesson VIII., *i.e.*, dissolve some phosphorus in bisulphide of carbon (CS_2). Moisten a piece of filter paper with the solution. The CS_2 quickly evaporates, and the finely divided phosphorus at once begins to unite rapidly with the oxygen of the air; *i.e.*, there is spontaneous combustion. White fumes of phosphoric anhydride (P_2O_5) are formed. In contact with water, this anhydride speedily dissolves and forms its acid, thus:—

$$P_2O_5 + 3H_2O = 2H_3PO_4.$$

This experiment proves the presence of oxygen in the atmosphere.

Perform the common experiment of burning a piece of phosphorus in a bell jar over water, as described in the reading book. The whole of the oxygen of the air is taken up by the phosphorus, giving rise to white fumes of phosphoric anhydride, which, falling into the water, turns it acid by the formation of phosphoric acid. The gas remaining in the jar is nitrogen. The water rises to about one-fifth of the height of the jar to replace the oxygen.

(Note.—In performing this experiment it will frequently happen that the water rises considerably higher than one-fifth. On one occasion at the school, it rose and half filled the jar; and the explanation gave rise to a rather animated discussion between me and the boys. If a rather large piece of phosphorus is used, the great heat generated, expands the air in the jar, and there is an outrush of a portion of it; the remaining air being hot and rare. Afterwards, when the phosphorus has burnt out, the jar cools, the enclosed air condenses, and so occupies a smaller space. This accounts for a much larger volume of water rising in the jar than would be the case if it were simply a question of occupying the space previously filled by the oxygen.)

The facts concerning the presence in the air of carbon dioxide, of aqueous vapour, of ozone, and of ammonia may here be recapitulated.

LESSONS XII. to XV.

These lessons deal with the elementary bodies, oxygen and hydrogen. I need not, however, give notes, for all the necessary facts and experiments are given with sufficient fulness in the Science Readers for Standards IV. and V.

(To be continued.)

Article 106 (*b*).

Merit Grant in Infant Schools.

BY MRS. MORTIMER,

Lecturer on Kinder-garten at the Home and Colonial Training College, London.

Section II.—Phenomena of Nature.

LESSON—THE SPRING.

Now, children, I want you to think about the different kinds of weather we have. What kind of weather is it to-day? It is wet weather. And do you remember what it was like yesterday? It was very bright and sunny. Was it hot? Not all day, it was very pleasant when the sun was shining. Yes, but there is one part of the year when it is very hot. Do you know what we call that time? The summer-time. Then there is another part of the year when it is very cold. What do we call that? The winter. That is right; the hot time we call summer, and the cold time, winter. Besides these we have two other parts of the year called Spring and Autumn. How many parts of the year have I told you? Four parts. Well, there is one name for these. We call the four parts, 'the Seasons.' Tell me the names of the seasons? Which is the hottest season? Which is the coldest? Spring comes between the winter and summer; that is, it comes after the coldest time and before the hottest time. Autumn comes after the summer or hottest time. Can you tell me what comes after the autumn? Yes, the winter or coldest time. So you see the four seasons together make up the year. How many months are there in the year? Twelve months. Yes, and each of the seasons is of the same length. Who can tell me how many months in each season?

Well, we will now talk about the Spring. When does the spring come? After the winter. What kind of weather do we get then? The weather begins to get warmer. Yes, the very cold weather is gone and the sun begins to stay with us longer each day, and looks brighter and makes us feel warmer. Do you not remember in the winter you were obliged to have a candle before you could get up? When you came out of school in the afternoon it was dark, and very often the teachers had to light the gas before school was over. Now the mornings are not so dark, and you are able to get up without a candle.

Did you have the gas in school yesterday? No, we do not have the gas now. Why not? Because we are able to see without. If we go out into the fields and gardens in the winter what do you notice about the trees? They look dead—there are no leaves on them. Well, in the spring you see them all beginning to grow. The buds on the trees are bursting into green leaves, and as the spring goes on the leaves can be seen all over the trees. And the pretty flowers or blossoms cover the trees, and make them look very pretty. Can you tell me some of the trees that have pretty blossoms on them? Yes, the apple, the pear, the plum. Yes, these are our fruit trees. Then the horse chestnut is very pretty with blossoms. Then if we look at the garden we shall find the flowers feeling the weather is getting warmer, as they begin to grow and burst out into bloom.

Can you tell me some of the pretty spring flowers? The crocus, the violet, the primrose, the daffodil, the tulip, the wall-flower. That will do. Besides these pretty flowers, you will be able to see everything in the garden is beginning to grow. The gardeners are very busy, sowing seeds and planting for the summer flowers.

Then if you watch the birds you will find them very busy indeed. Have you seen them flying about with bits of straw and wool in their mouths? They get these things to build their nests. Why do they build nests? Yes, this is the time of year the birds lay their eggs. I daresay you will wonder where so many of the birds come from. They have been to a warmer country during our cold winter, and when the spring comes back, they come to us again. Can you tell me the names of some of these birds?

Section III.—Scenes of Common Life.

LESSON—WRITING A LETTER.

I. Introduction.—Now, children, when do you have holidays? In the summer and at Christmas. What do you do in your holidays? The teacher, of course, to this question would obtain many different answers. Well, Mary, what do you want to say? I went into the country. Did any one go with you? Yes, my father, mother, and sister. James says he also went into the country to see his aunt, and nobody went with him. Were you happy while you were there? Did you ever think of your father and mother? Did you want to speak to your mother? Yes, I wanted to tell her how happy and how well I was, and what fun I was having every day. Why did you not tell her? Because I was such a long way from her. Well, how could you let your mother know all you were doing? By writing a letter to her.

Now I want you all to help me this morning to write a letter, and we will suppose we are in the country and sending word home to our mother. On what shall we write the letter? On paper. Who can tell me what we call the paper we use for letters? Yes, it is called note-paper. Come and show me some note-paper. What do we call each piece of paper? A sheet of paper. What colour is it? It is white. Have you seen any note-paper that was not white? Yes, I saw some blue note-paper. Harry says he saw some yellow paper; another little boy says his mother had some pink paper, and Jane says she has some green note-paper. Now look at this pink, yellow, green, and blue note-paper, and tell me what kind of colours they are? They are all very light colours. What else can you tell me about this paper? It feels very smooth, and you are able to fold it.

II. Contents.—Now how shall we begin our letter? Well, see here is a letter I had this morning. What can you see has been written first? Something in the corner. In which corner? In the right top corner. I will read it to you. This is what is written here: '27, Silver Street, Southend, July 14th, 1884.' What do you think that tells you? Yes, it is the place where the little boy is staying. Do you know what we call this? Yes, the address. Why do we want to write the address? Yes, that is right; it is to let the person to whom we are writing know where we are. Why? So that he can write back an answer to us. What do we call 'July 14th, 1884?' The date or time. Of what does the date consist? The month, the day of the month, and the year. Why must we put the date on a letter? So that the person to whom we are writing may know exactly when we wrote the letter. If we did not put the date on the letter, and said, 'I shall be home to-morrow,' your mother would not know which day you meant. Why would she not know? Because she would not know on which day you wrote the letter. Can any of you tell me what is the date of to-day? What month is it? What year?

Now let us see what comes next in the letter; will you read it, Mary? 'My dear mother.' That is right. If you were to write to your father, what would you put? What to your sister? Now we will write a letter on the blackboard. What do we put first? The address. Where shall I begin? Near the right top corner. Tell me the address of the school. What must I write next? The date. What is the date to-day? Where do I write the date? Under the address. What have I to write next? The name of the person to whom you are writing. Where do I write it? Do I write it under the date. Well, look at this letter and tell me where the name is? On the left side of the paper. Do I put it at the top on the left side? Oh no, lower down than the date. The blackboard would then have on it:—

Hope School,
Pleasant Road,
London, N.,
20th October, 1884.

My dear Mother,—

What do you put after that? You then begin to write down all the news you have to send. The teacher should

then get the children to compose a letter, and as they proceed she should write it on the blackboard.

Now, I want you to look again at this letter. What do you call this part of the letter? The end. What do you see at the end? A name. Whose name do you think it is? The name of the person who wrote the letter. And what can you see just above the name? Three words. We will ask Harry to read them to us. 'Your loving son.' Yes, we always write something like this before we write our name. If a little girl wrote a letter to her mother, what would she put? 'Your loving daughter.' And if she were writing to her brother or sister, what would she write? 'Your loving sister.' And what would a little boy put? Sometimes we write, 'Your affectionate son,' instead of 'loving son.'

Now, we must finish the letter on the board. What shall we put? Why is it necessary to put our name in the letter? We should not know who had sent us the letter. The teacher should explain about letters going to the wrong house, and also going to houses when the people have removed, and how the postman takes these letters back to the post-office. Here they are opened, and then the name and address inside enable the postman to return them to the writers of the letters.

III.—What is done with the letter after it is written? It has to be folded. Into what size? A size that will fit the envelope. Of what use is the envelope? It holds the letter safely. It keeps it clean. And what else? When the letter is in the envelope can you see the writing? Well, then, the envelope prevents the postman or anybody else from reading the letter. What do you do when the letter is in the envelope? Fasten it. How can you do this? There is some gum on the envelope, and when you wet the gum and press the envelope it keeps shut. Now, what else must you do? Write on the envelope. What do you write? The name of the person to whom you have been writing and the address. Why do you do this? In order that the postman may know where to take the letter. What do you do after you have written the address? Put it in the post. But you must put something else on the envelope. What is it? A postage stamp. Where do you get that? At the post-office. What is the use of the stamp? It shows that the letter is paid for. How much did you pay for the stamp? A penny. Well, if you had not put a stamp on, the person to whom you wrote would have had to pay twice as much. How much would that have been? When the stamp is on how much does he have to pay? Nothing. Where shall we post the letter? In the pillar-box. Does it stop there? Who takes it out? The postman. What does he do with it? He takes it to the post-office with all the others. Yes, and then they are sorted and given to the postmen to take to the different houses.

Section IV.—Common Employments.

LESSON—THE PAINTER.

Apparatus—Various coloured powders, linseed oil, turpentine, white lead, putty, sand-paper, pumice stone, and a few brushes.

I daresay you can all tell me some things that the carpenter makes. Now, when he has made the doors, windows, cupboards, etc., are they quite finished? Well, perhaps you can tell me what has to be done to the windows? The glass has to be put in. Who does this? The glazier? Something else has to be done to all these things. What colour is the wood when the carpenter has finished? Are they the same colour when we live in the house? What changes the colour of the wood? The paint. Who paints the wood? A man called a painter. Now, I should like to have a long talk with you about the painter. Do you know what he has to do first? Will you tell me some of the things he uses? Paint and brushes. What is this I have here? Some paint. What can you tell me about it? It is green. Is paint always green? No, it is of different colours. Tell me some of them. Can you tell me now what the painter has to do first? Yes, he must get his paint ready. We say he has to mix his paint, because the paint is made of a number of different things mixed together. Here are some of the things the painter uses to make his paint. What is this? It is oil. Yes, it is *linseed oil*. This is called *white lead*. Then this is very much used, and if you smell it I expect you will be able to tell me its name. It is *turpentine*. Then the painter has to put in something to make the colour. Will the same thing do for all the colours? No, if he wants yellow paint he must have some *yellow powder*. If he wants red he must use *red powder*. Here are some different powders, and I want you to tell me their colours. What colour is this? And this? And this one? etc. Then besides these, the painter uses other things, but these you must learn another day. Where does the painter put the paint when he is going to use it? In the paint-pot.

Now, look at these paint brushes. What can you tell me about them? They are all long. Which part is long? The handle. Of what is it made? It is made of wood. Why does the painter want a long handle? To hold the brush, and keep the paint from getting on his fingers. Why does he not like it on his hands? Have you had any paint on your hands? How did you get it off? Could you wash it off? No, mother had to rub some grease on my hands, and then it came off. Yes, but besides that, the paint sometimes makes our hands very sore. So you see you must be careful not to touch the paint. How is it when I touch this door the paint does not come off on to my hands? Because the paint is dry. Is it dry when the painter puts it on the door? When is it that you must not touch paint? When it is wet. Now, look at the brushes again, and show me another part beside the handle. Of what is this part made? Of hair. We say it is made of bristles. Feel how soft they are. The painter does not like a hard brush. Are all the brushes the same size? No, some are large, and some are small. Do you know why the painter wants brushes of different sizes? Well, perhaps, you will be able to tell me some other time, when you have watched the painter at work.

When the painter has his paint and brushes ready he has to look at the wood he has to paint. The wood must be very smooth. If there are any nails in it he gets a punch and knocks the heads of the nails into the wood. This leaves a number of small holes, and these the painter fills up. What does he use to fill up the holes? Some putty. All the rough places he rubs with sand-paper or pumice stone. What does this do to the wood? Who can show me the pumice stone? Which is the sand-paper?

Now the wood is quite ready for the paint. Who has seen a painter at work? How does he move the brush? Yes, he moves it up and down. Why does he not move it about any way? The painter wants the paint to be very smooth and not to show the marks of the brush, and he does not press very hard. If you watched him carefully you will see that after he has painted the wood once he lets the paint get quite dry and then he paints it all over again. We call this putting on another coat. How many coats would that make? Two. Sometimes they put on three or four coats. Of what use is this paint? Yes, it makes the wood look better, and the house looks more finished. There is, however, another reason why we paint the wood. It keeps the wood from rotting or wearing away. When the wood is outside the house the rain would soon rot it if it were not painted. We say the paint preserves the wood. Then again: sometimes when boys and girls are playing their hands are dirty, they put them on the paint and make dirty marks. What does your mother do then? She washes the dirty marks off the paint. Can she wash the paper on the walls? No; it would spoil the paper. The *summary* written on the blackboard would be as follows:—

The painter uses paint and brushes.

The paint is made of white lead, linseed oil, turpentine, coloured powder, etc.

The painter's brushes are made of long handles and soft bristles.

The painter puts on several coats of paint, and each one must be dry before the next goes on.

LESSON—PAPER MAKING.

I. *Qualities.*—What have I in my hand? Look at it and see what you can tell me about it. Is it white? Yes, is this piece white? Is this piece blue? What colour is this? What will you say about the colour of paper? Paper is of different colours. How does it feel? It feels very smooth; it is thin and light. What am I doing to it now? Folding the paper. Then you see we can fold paper. What do we say of those things that we can fold? We say they are pliable. What am I doing to the paper now? Tearing it. How would you say it tears? Very easily. What else can you tell me about paper? Why does your mother use paper when she lights the fire? Because it burns quickly? Then you see paper burns easily and with a flame. What do we say of those things that burn with a flame? They are inflammable. Now we will write on the blackboard what we have learnt about paper.

II. *Of what made.*—Now look at these pieces of paper. Can you think of what it is made? See I have here some mixed rags. Can you believe that paper is made from rags like these? Well, most of these pieces of paper were made from rags, and nearly all the paper we use is made from them. Then besides the rags there are some other things used for making paper; here are some of them. The teacher should then show the children some rope, grass, straw, and waste paper. Sometimes you can see small pieces of straw in brown paper. Do you not think it is very wonderful to be able to turn these things into nice paper like this?

III. *How made.*—Well, I daresay you would like to know how the men make these things into paper. I will tell you a little about it now, and when you are older you must read more about it. Do you know what we call the people who make paper? Yes, they are called papermakers. How does the papermaker get the rags to make into paper? Well, what does your mother do with her rags? She sells them. To whom does she sell them? To the man at the rag-shop. Yes, and if you go to the rag-shop you can see large sacks full of rags. These are sold by the man to the papermaker. So you see the papermaker can get plenty of rags. What kind of rags does he get? All kinds. Yes, he gets old and new, dirty and clean, and all sizes and colours. Then what do you think the man does with them? That is quite right, Harry; he must sort them. He separates the clean from the dirty. They are then put into a machine that turns round and round and shakes the rags about. The bottom of the machine has many small holes, and through these a great deal of the dirt and dust falls out. There are some sharp knives in the machine, and these cut the rags into small pieces. The rags are then boiled, and something is put in with them that makes all the rags quite white and clean. When they are quite white and clean they are put into another machine which has a great many knives in it. These knives turn round and round. What do you think becomes of the rags in this machine? They will be cut into very small pieces. Yes, the rags are cut in the smallest pieces possible. After this something is done so as to turn these pieces into what is called *pulp* (some of this should be shown). What is this pulp like? Thick milk or cream? What is it really made of? Of the rags beaten up very small. The pulp is then pressed through a machine which squeezes all the water out of it, and rolls and presses it on thin wire gauze (some of this should be shown), and when dry it is paper.

IV. *Summary.*—This should be written on the blackboard as the lesson proceeds.

Paper is smooth, thin, light, of different colours, pli-a-ble, very easily torn, and in-flam-ma-ble.

Paper is made of rags and other things, as rope, grass, straw, and waste paper.

When it is made of rags, the rags are: 1, sorted; 2, put in a machine that shakes the dust and dirt out; 3, boiled to make them white and clean; 4, another machine cuts them into tiny pieces; 5, then beaten into pulp; 6, made into paper.

(To be continued.)

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My Certificate Answers.

BY ARTHUR DAY,

Assistant-Master, Bridge Street, 7th Standard Technical School, Birmingham; First in the First Class at the Borough Road College, Christmas, 1883.

(Continued from page 411.)

POLITICAL ECONOMY.

Define capital. Distinguish fixed and circulating capital. Discuss the statement that the industries of a country are limited by its capital.

Capital is that part of wealth which is put aside to assist in future production.

Circulating capital is all consumed in fulfilling its office once, as, for instance, wheat sown by a farmer does not do for several years, but the field must be re-sown every year.

Fixed capital exists in a substantial form, and is only gradually consumed, as the plough, the horses, etc., of the farmer, which last for years, and assist in several successive periods of production.

In order for there to be industries, there must be capital. Let us suppose a barbarian tribe living from hand to mouth; as the food comes daily it is eaten. Not having any stores, they cannot sit down and work at any trade, for their time is taken in the chase, or other form of a daily struggle for food. If by any means they came across a store of food, then they might employ their time in any industry they pleased until the stock of food had vanished. In a civilised country there must always elapse a certain time before the articles manufactured bring their returns, but the artisans cannot wait six weeks for food; they must have food, firing, clothing, etc., at once; the materials for turning out fresh work must be advanced; and hence, if the master has not these things or the money necessary to procure them, the industry is at a standstill.

Prove by illustrations that the rate of wages is principally regulated by competition, and name some of the circumstances which practically modify the action of competition.

An advertisement for a clerk fetches hundreds of applicants. Why? Because there are so many who, having had a small education and wishing to appear gentlemanly, would take the place. Now, if the salary were £100, there would be a certain number of applicants; if it were reduced to £80, several would withdraw; and so on until at last only a few would consent to take the situation.

Competition is modified by certain class considerations, and by the amount of money it costs to learn the trade or profession. For instance, in order to become a lawyer, a long term of study and waiting for clients has to be experienced, which take much capital; also the lawyers regulate competition by regulating the number of articled pupils.

Again, the wages of miners are high, because many would not consider it respectable enough to be a miner; others would not have a constitution strong enough to stand it, or have had experience.

What gives value to a Bank of England note and to an ordinary cheque drawn by a private person on his banker? How do banks employ the money of their depositors?

A bank-note is a promise by the chief cashier on behalf of the governors to pay the sum named thereon to bearer on demand. As long as the bank is solvent, and does not stop payment, anybody by presenting the note can receive the amount. A cheque orders the bankers it is drawn upon to pay some one (bearer or otherwise) the sum stated from the accounts of the

one who signs the cheque. As long as money stands to this man's credit, and his bankers are solvent, the cheque is worth the sum stated; on failure of either of these conditions, it loses its value.

The money deposited in banks is invested by the banks in various ways, such as lending it to a Government, or taking shares in railways, canals, mines, etc.

Show that the rent of land is regulated by the excess of its produce over that which would be produced on the worst land in cultivation with the same expenditure of labour and capital.

Let us suppose a farmer A, who only secures returns enough from his land to pay him the current rate of interest on his capital. He would pay no rent, for if rent was charged he would withdraw his capital and invest it so as to get the current rate. If, now, another farmer, B, gained more by his land, he must pay rent, otherwise other people, seeing him gaining more than the current rate of interest, would offer the landowner some rent to have the land instead. But if the landowner asks B for more rent than his excess of produce over A, B will prefer to cultivate land similar to that of A, and no one else will take his land unless he can gain the current rate. Hence these fluctuations on either side would soon determine the rent as stated.

Enumerate the principal advantages arising from the division of labour in the production of any article in common use.

A Pen.—One man stamps it from the rolled steel, another bends it to shape, another hardens it, another scours it, and so on. Each man becomes very dexterous in his particular duty, more dexterous than if he devoted his time to different duties. Also by continually working at one process he does not lose time in having to change his tools or pass from one occupation to another, and each man can be used for the duty which is most suitable for him. Some men could not stand the heat of a furnace or lift heavy articles, others would not have inventive capacity for new designs.

Illustrate the statement that uncertainty of success has considerable influence in regulating the remuneration of any employment.

A man studies for the law. Desiring to become a barrister, he risks a large sum of money in preparing himself, and he is not at all certain that when fully qualified he will have clients, or that he will ever make a name. If he does, he then will ask high remuneration in return for the risk, and he will be able to get what he asks, because many men will have been deterred by this uncertainty from entering the profession.

An agricultural labourer can often demand good wages in the colonies, because the uncertainty of obtaining employment has deterred others from emigrating, and consequently, the supply being small, he can get better wages.

What is generally understood by the 'natural value' of any article? Show that the value of all things that cannot be be indefinitely increased is governed by demand and supply.

By 'natural value' of any article we mean its intrinsic value, that is, the amount of another commodity it will exchange for, and which amount will vary according to the value of the first article not of the one it exchanges for, which would 'extrinsically' affect the price.

Suppose there are 10 plots of land for sale in a fertile and healthy locality, and possessing other advantages. Many persons would desire these plots, and there might be 100 willing to give £1000 for each, but only 50 of these would give £2000, 20 would give £3000, and so on, until at a certain price 10 would be the only ones remaining, and these would have the lots. The demand here has raised the price. But if it had been possible to throw 10 more plots in the market the 20 desirous purchasers at £3000 would have all been accommodated, and the greater supply would have diminished the price.

14. Prepare the outline of a lesson to an advanced class on one of the following:—

(*a*) The relations of capital and labour;

(*b*) The considerations which govern the rate of wages;

(*c*) Councils of conciliation and arbitration between the employer and the workman.

(*b*) Take up daily paper. Read advertisement for errand-boy or office-boy, and ask how many would go? Some hesitate. Why? 'Please, sir, what's the wages?'

'Suppose all you boys went, and offered yourselves,' etc.; thus trace out that many offering, would lead to him giving low wages; and only few applicants, to higher wages. Write on board, 'If supply is greater than the demand prices (or wages) fall.'

Now begin to add conditions:—

Pleasantness, or unpleasantness (as miners).

(1) Must be there from 6 a.m. to 10 p.m. How many would go now? Fewer hands than before. Why? Not *pleasant* to work so long; write down on board, 'Pleasantness or unpleasantness,' and from the statement above let them see that if the task is disagreeable wages would be higher, and *vice-versâ*.

Ease or difficulty, cheapness or expense of learning (doctors, mechanics).

(2) Must know book-keeping, speak French, etc. Few again. Why? Because these things are hard to learn, and cost money. As before, show how the number affects wages, and ask if interpreters get good or bad wages.

Constancy or inconstancy (builders).

(3) Only employed three days a week. As before some would not go. Ask why? They want *constant* employment. Mention again, 'If few are willing then wages higher.'

Amount of trust (cashiers).

(4) Must have good testimonials for honesty, and be greatly trusted. Trace out how it affects wages. Do bank cashiers have small or large salaries?

'Chance of success' (lawyers, doctors).

(5) In a year be paid 30s. a week. All are ready to go. Only be paid if no mistakes are made. Not many. Hence, 'chance of success' affects number applying and affects wages. Recapitulate all these points, which should previously have been written on B.B. And let the boys supply instances in trade of high or low wages as a consequence of each cause, and write these opposite the cause.

School Management.

SCHOOL REGISTERS.

1. When, and by whom, should the daily attendance and absence of scholars be marked and verified? How would you endeavour to secure correct marking, and what should be done in case of error, or the withdrawal of a child during school hours?

Give an extract from an attendance register for one week: explain the marks used, and show how the particulars required in the book of summaries should be obtained.

Specify, in detail, the rules with regard to—

(*a*) Calculation of average attendance.

(*b*) Removal from the registers, and re-admission.

(*c*) Qualification of a scholar for entry on the examination schedule.

The daily attendance should be marked by the responsible teacher of a class (*i.e.* head-master, assistant, or pupil teacher above second year). To secure correct marking call the names, and let every one present answer, 'Here, Sir!' then count up the column the number marked present, count the class, and the two totals should coincide.

In case of error correct by a foot-note. If a child is withdrawn during school hours a mark should be drawn across the attendance mark, and the total at the bottom corrected by a footnote. (See extract.)

To calculate the average attendance divide the total number of attendances made by the number of times the school has been open.

A child may be removed from the register and marked left if absent 6 weeks, or before this, if definite information as to withdrawal has been received.

On re-admitting such child a new admission number must be assigned to it.

NAME.	M		TU		W		TH		F		TOT.
Alton, Fred.	/	\	/	\	*a*	\	/	\	*s*	*s*	7
Brown, Thom.	*a*	..	L	E	F	T	...	...	...	...	0
Banks, Will.	/	\	/	\	/	\	/	\	/	\	10
Cook, George.....	/	\	×	\	/	\	/	\	/	\	9
Jones, Walt.	*a*	*a*	*a*	*a*	*a*	*a*	*a*	*a*	*a*	*a*	0
King, John.....	/	\	/	\	/	\	*a*	*a*	/	\	8
Morris, Will.	/	\	/	\	/	\	/	\	/	*a*	9
Smith, Alf.	*a*	\	*a*	\	*a*	\	*a*	\	*a*	\	5
	5	6	4	6	4	6	4	5	4	4	

Total Attendances 48
No. present at all 6
No. on register 7

A scholar is qualified to be put on the examination schedule if its name has been on the register during the last 22 weeks of the school year, *i.e.*, its name must have been on at the beginning of this period and continue on.

The marks on the extract above—

/ morning attendance.
\ afternoon ,,
a absent.
s ill.
× attendance cancelled.

The figures at the bottom indicate the numbers present at each opening of the school.

The figures at the side, the total made by each child for the week.

The particulars for the book of summaries are given underneath. Add up column of totals for the total attendance. Count number of those who had any attendance marked, for 'No. present at all.' Count number of all those not marked left, for 'No. on register.'

2. On what principle would you classify your scholars, if you were called on to organise an entirely new school? Say what advantages, if any, there are in making separate classification for special subjects; and what are the reasons in favour of the ordinary practice of keeping the same scholars together for the whole of their instruction.

I should classify them according to their ability in 'reading' (unless, of course, they had at other schools passed any standard); because reading tests a child's general ability; arithmetic only shows a special aptitude, and writing a correct eye and steady hand; for this reason it is advantageous to have separate classification, as some children do have an inherent aptitude for figures, others for writing, etc., and these should be allowed to go forward, not held back by others.

On the other hand, the general method places a child continually in competition with the same children, and if he wishes to hold his own, or rise, he can only do it by striving to improve in the branch he is backward in. Also the teacher has the same children continually under him, and consequently knows them better, and brings them forward in all branches of their education. Another reason is that the working of the school is greatly simplified.

What is meant by 'habit,' and by what means is habit formed and strengthened? Are there any youthful habits, either of thought or of action, which lie specially within the control of the school teacher?

Habit is a tendency of the body or mind to act in a particular way when subject to certain conditions, without seeming to be influenced directly by the will. Thus a well-bred person on entering a house will remove his hat, though engaged in conversation; the hand will rise to the head because the habit is formed. Habit is formed and strengthened by continued and uninterrupted repetition of the acts, at first with only small intervals in between, and with no exceptions, afterwards at longer intervals. Such habits as cleanliness, politeness, attention, concentration of mind and abstraction from hindrances, prompt obedience, doing everything as well as possible—all these are habits which may be instilled by the teacher.

14. Mention any books relating to the History or the Philosophy of Education which should be read by any one who is anxious to become thoroughly qualified for the profession of a teacher, or which you hope to read at leisure after your college course is complete, and give your reasons for the selection.

Spencer 'On Education;' *Bain*, 'Education as a Science;' *J. S. Mill*, 'Psychology.'

All these books give an insight into the development of the intellect, and how this natural method should be applied by a teacher to his work.

Locke 'On the Understanding;' 'Thoughts on Education;' *Roger Ascham*, 'The Schoolmaster.'

Lives of some educationalists, as Pestalozzi, Dr. Arnold, etc. These will enlighten on the thoughts of men at other periods beside our own, and comparison will be instructive.

Show by means of brief notes of a lesson on *one* of the following subjects, how you could help a scholar to think out and find a rule or principle for himself:—

(1) Multiplication of Fractions.
(2) Laws of Gravitation.
(3) Choice of Food.
(4) Difference in the rate of wages.
(5) Formation of abstract nouns from adjectives.

Apparatus.—Several little squares of wood, and some larger rectangles that are multiples (as 12, 6, 10, etc.) of these.

Build up a rectangle of 6 squares same size as one piece. Show it to be of the same size, and then divide the 6 into two groups of three. Ask what fraction? $\frac{1}{2}$. Now ask for a third of one of these groups, namely, one square, and elicit that this is one $\frac{1}{3}$ of the large one. Write on board $\frac{1}{3}$ of $\frac{1}{2}=\frac{1}{6}$. Repeat the operation in various ways, as $\frac{1}{2}$ of $\frac{1}{3}$, $\frac{1}{3}$ of $\frac{1}{2}$, $\frac{1}{2}$ of $\frac{1}{4}$, etc. Write down one underneath another, and then let the boys notice the result, and tell you the connection of parts; they will soon see that $\frac{1}{2}$ of $\frac{1}{3}=\frac{1}{6}$, that the 3 is × by 2.

Now do some more in the same manner, with such as $\frac{2}{3}$ of $\frac{3}{4}$ (with 12 squares) $=\frac{6}{12}=\frac{1}{2}$; $\frac{2}{3}$ of $\frac{3}{5}$, $\frac{3}{4}$ of $\frac{4}{5}$, etc.

Now the boys will notice that the numerators are multiplied as well, and after numerous instances they will give the rule to 'Multiply together all the numerators and all the denominators.'

Say by which of the exercises of Fröbel or by what other discipline in higher classes can the inventive faculty of children be strengthened.

By exercises, such as the construction of solids with peas and wooden rods, forming eggs, nests, etc., of pipe clay, children in low classes would be disciplined. In higher classes a course of inventive geometry is recommended by Spencer; constructing plane geometrical figures with wire or cutting them out in paper; constructing solids of cardboard or tin by marking out the development, scoring the card, and doubling to shape; very little apparatus is needed, and every teacher of geometry should let the models be constructed by his class, at any rate with cartridge paper.

In the lower classes as well there are the exercises with coloured paper, forming patterns by weaving strips together, and various shapes by doubling can be made.

If your advice were asked by the managers, respecting the formation of a lending library in your school, what classes of books would you suggest? Name in each case two or three examples of books well suited for the purpose. By what other means is it in the power of a teacher to encourage in the scholars a love of reading?

Books of Travel, etc., as 'Robinson Crusoe,' 'Cook's Voyages,' 'Swiss Family Robinson.'

Natural History—Rev. J. Wood's 'Stories about Animals,' 'Anecdotes of Dogs,' etc.

Books for the Imagination—Andersen's and *Grimm's* 'Fairy Tales,' *Æsop's* and *Mrs. Prosser's* 'Fables.'

Fiction—Jules Verne's works, *Scott's* 'Ivanhoe,' etc.

Tales of Home Life—as 'Wide, Wide World,' 'The Gates Ajar,' 'Uncle Tom's Cabin,' etc.

Observation—'Sandford and Merton,' 'The Wonders of the Sea-shore.'

Poetry—Scott's, Macaulay's, Longfellow's, 'Tennyson for Children.' Some of *Shakespeare's.*

Biographies—Smiles' 'Life of Stephenson,' etc.

I should encourage a love of reading by continually in lessons referring to books, mention books of travel in geography lessons, biographies in history lessons, and devote a short time each week on Friday afternoons to reading from some well-known book,

allowing the children to bring a copy from home, and by giving occasional lessons on some authors' lives and works, reading selections.

It has been officially explained that one of the chief objects of exercises in English should be to add to the scholars' store of words. Say why it is desirable to do this, and by what sort of exercises the object can be most effectively attained.

It is desirable for a child to have a good store of words, for then it can express itself clearly, it can understand what others say, and can appreciate books. Also it is impossible to have a good store of words without a knowledge of the *things* referred to, and this must always be borne in mind in exercises of this kind. It is no use to tell a child to cram into its head a page of a dictionary, but select anecdotes, and later on good descriptive poetry, read it with them, point out the things referred to, and describe in their language the same scenes; let them afterwards write on their slates from memory the substance of the passage n their own words, and they will soon be able to combine the expressions of the book with their own language. In regard to poetry, *after* this kind of exercise they should commit the lines to memory, but it is no use so doing unless they previously thoroughly understand it and have a real knowledge of it.

PENMANSHIP.

Parenthetically.

The castled crags of Drachenfels.

It would be absurd to suppose that any of the constituent elements of military genius, which nature furnishes to energetic characters, were wanting to the leaders of a barbarian or feudal army; untroubled perspicacity in confusion, firm decision, rapid execution, providence against attack, fertility of resource and stratagem, these are as much required from the chief of a guerilla horde as from the accomplished commander. But rarely are they so consummated by habitual skill as to challenge the name of generalship.

List of Books Used.

Todhunter's *Algebra.*
Pott's *Euclid.*
Wrigley's *Mathematical Problems.*
Shakespeare's *Julius Cæsar.* Edited by Aldis Wright.
Bacon's *Essays.* Edited by Dr. Abbott.
Mrs. Fawcett's *Political Economy.*
Macaulay's *Essays on Lord Chatham* and *Warren Hastings.*
Curtis' *History of England.*
Ludlow's *History of the American War.*
Locke's *Thoughts on Education.*
Hachette's edition of *Lazare Hoche* and *Iphigenie.*
Dr. Smith's *French Principia.* Pt. I.
Baume's *French Grammar.*
Spencer's *Education.*
Rev. Stopford Brooke's *Sketch of English Literature.*
Hullah's *Grammar of Musical Harmony.*
Science and Art of Teaching. (National Depository.)
Shakespearian Grammar. Dr. Abbott.

Recent Inspection Questions.

[*The Editor respectfully solicits contributions—all of which will be regarded as* STRICTLY PRIVATE—*to this column. For obvious reasons, it cannot be stated in which district the questions have been set.*]

Arithmetic.

STANDARD I.

369	708	
407	367	
58		
987	341	Ans.
12		
1833	Ans.	

STANDARD II.

(1) Multiply ninety-five thousand and seventy-six by nine. Ans. 855,684.
(2) Multiply 67,249 by 87. Ans. 5,850,663.
(3) Divide 64,207 by 11. Ans. 5,837.
(4) A lady had 350 yards of calico. She kept 120 yards, and divided the remainder among ten women. How many yards did each receive? Ans. 23.

STANDARD III.

(1) Divide one hundred and nine thousand, six hundred and eighty by ninety-eight. Ans. 1119+18.
(2) From sixty thousand and four pounds, nine shillings and twopence farthing take eight hundred and seven pounds, thirteen shillings and eleven pence halfpenny. Ans. £59,196 15s. 2¾d.
(3) Add together £6 2s. 9¼d.; £504,290 16s. 8½d.; £9,760 18s. 11¾d.; £93,278 9s. 4¼d.; £602,190. Ans. £1,209,526 7s. 9¾d.
(4) I borrowed £10, and shall pay back £1 9s. 4d. on Monday, 9s. 6d. on Tuesday, £2 7s. 6d. on Wednesday, and £4 1s. 7d. on Thursday. How much must I pay on Friday so that I may then not owe anything? Ans. £1 12s. 1d.

STANDARD IV.

(1) £6,073 14s. 6¼d. × 87. Ans. £528,414 3s. 3¾d.
(2) Divide two hundred and six thousand, nine hundred and eight pounds, three shillings, and a farthing by twenty-nine. Ans. £7,134 15s. 3¼d. +8.
(3) Reduce 605,978 inches to miles, etc. Ans. 9 mls. 4 fur. 20 po. 2 yds. 2 ft. 2 in.
(4) Divide £2 17s. 5d. among 17 persons, so that one may have 5 shillings more than each of the others. Ans. One has 8s. 1d.; the others have each 3s. 1d.

STANDARD V.

(1) 309 things at £47 1s. 8¼d. each. Ans. £14,544 1s. 5¼d.
(2) Find the cost of 36 ac. 2 rds. 19 po. of land at £6 3s. 4d. per acre. Ans. £225 16s. 3¾d.
(3) Make out a bill for 17 lbs. of sugar at 5¾d. a lb.; 15 lbs. of tea at 2s. 9½d. a lb.; 3 doz. oranges at ¾d. each; 9 balls of string at 1s. 6d. per dozen balls. Ans. 8s. 1¾d. + £2 1s. 10½d. + 2s. 3d. + 1s. 1½d. Total £2 13s. 4¾d.
(4) A garrison of 2,100 men has provisions for 9 months, but receives an addition of 600 men. How long will the provisions last? Ans. 7 mos.

STANDARD VI.

(1) Simplify $\frac{8}{9}$ of $6\frac{3}{4} + \frac{17}{20}$ of $\frac{4}{51} - \frac{6}{7} \div 1\frac{1}{14}$. Ans. $5\frac{4}{15}$.
(2) Divide the product of ·0136 and 16·2 by 3060. Ans. ·000,072.
(3) If £12 will pay 8 men for 5 days' work, how much will pay 32 men for 24 days' work? Ans. £230 8s.
(4) Find the interest on £3,256 15s. for 5 years, at 2½ per cent. per annum. Ans. £407 1s. 10½d.

STANDARD VII.

(1) A man buys goods for £23 5s. 5d., and sells them for £22 2s. 1¾d.; how much does he lose per cent.? Ans. 5 per cent.

(2) Find the present worth of £678 8s. due 16 months hence at 4½ per cent. Ans. £640.

(3) What is the annual income derived from investing £6050 in the 3 per cents. at 90¾? Ans. £200.

(4) If $\frac{5}{7}$ of the cargo of a ship be worth £16,200, what is the value of $\frac{2}{3}$ of $\frac{7}{8}$ of the remainder? Ans. £3780.

Dictation.

STANDARD I.

Words for dictation:—Blue, chair, flower, house, night, plant, summer, table, truth, world.

STANDARD II.

(*a*) A crow, ready to die with thirst, beheld a pitcher at some distance, and flew to it with joy. When he came to it, he did indeed find water in it, but so near the bottom, that with all his stooping and straining he was not able to reach it.

(*b*) The next day the giant came and looked at Dick, and finding that he had eaten none of the bread, he took him by the head, and crammed some of the bread down his throat. Poor Dick, who was nearly choked to death, was in too great a fright to think of eating or drinking.

STANDARD III.

(*a*) So the little girl wandered about barefooted, with a quantity of matches in an old apron, whilst she held a bundle of them in her hand. Hungry, and pinched with cold, she crept along, the large flakes of snow covering her yellow hair which curled round her face. It was dreadfully cold, and was beginning to grow dark.

(*b*) Everybody knows that the sparrow is a small, stout, active, and sometimes very noisy bird; not clad in any gay plumage, like some of its neighbours, but very happy and contented in its humble station, and generally in good spirits. As a rule it is rather sociable, and likes the company of its fellows.

STANDARD IV.

(*a*) Thus had George Stephenson, the poor fireman's child, become a great and celebrated man. He had fought a hard battle, and, but for his wonderful perseverance, would many a time in his youth have been discouraged and cast down. Now he was greatly sought after, both at home and abroad, and was honoured by kings and princes. Yet he was still the same humble-minded man, and never forgot his poorer friends in the time of his triumph.

(*b*) We thought as we hollowed his narrow bed,
And smoothed down his lonely pillow,
How the foe and the stranger would tread o'er his head,
And we far away on the billow!
But half of our heavy task was done
When the clock struck the hour for retiring;
And we heard the distant and random gun
That the foe was sullenly firing.

Parsing.

STANDARD IV.

(*a*) Near the end of the lane we met several children on their way to school.

(*b*) My young friend went to Blackpool yesterday at nine o'clock.

STANDARD V.

(*a*) They will return when the weather is milder.

(*b*) The teacher placed the flowers, which the children brought with them, on the table by her side.

Writing.

STANDARD V.

Dictation.—It was on Friday morning, the 12th of October, 1492, that Columbus first beheld the New World. As the day dawned, he saw before him a level island, several leagues in extent, and covered with trees like a continual orchard. Though apparently uncultivated, it was populous, for the inhabitants were seen issuing from all parts of the woods, and running to the shore. On landing, he threw himself on his knees, kissed the earth, and with tears of joy returned thanks to God.

Composition.

STANDARD VI.

(*a*) Make up a short story about a clever dog, by enlarging the following outlines:—

(1) A gentleman stops his gig in front of a shop.
(2) Leaves his dog on the seat.
(3) Horse takes fright, and runs away.
(4) Dog jumps down, seizes reins in his teeth, and stops horse.
(5) Thanks of his master.

(*b*) Write a short theme about the duty of kindness to animals.

Parsing and Analysis.

(*a*) I saw from the beach, when the morning was shining,
A bark o'er the waters move gloriously on.

(*b*) Where once we dwelt our name is heard no more.

ANSWERS TO Pupil Teachers' Examination Papers.

OCTOBER 25TH, 1884.

FIRST YEAR.

Pupil Teachers at end of First Year.

Three hours and a half allowed.

Arithmetic.

MALES.

1. Reduce to a simple fraction $\frac{\frac{1}{2}+\frac{1}{3}-\frac{1}{4}}{\frac{1}{2\frac{1}{2}}+\frac{1}{3\frac{1}{3}}-\frac{1}{4\frac{1}{2}}} \div \frac{2\frac{1}{2}}{3\frac{1}{3}}$.

$$\frac{\frac{1}{2}+\frac{1}{3}-\frac{1}{4}}{\frac{1}{2\frac{1}{2}}+\frac{1}{3\frac{1}{3}}-\frac{1}{4\frac{1}{2}}} \div \frac{2\frac{1}{2}}{3\frac{1}{3}}$$

$$= \frac{\frac{1}{2}+\frac{1}{4}-\frac{1}{5}}{\frac{2}{5}+\frac{3}{7}-\frac{2}{9}} \div \frac{17}{180}$$

$$= \frac{\frac{6+4-3}{12}}{\frac{126+90-70}{315}} \div \frac{17}{180}$$

$$= \frac{7}{12} \times \frac{315}{146} \times \frac{180}{17}$$

$$= \frac{17820}{1242}$$

$$= 14\frac{342}{1242}. \text{ Ans.}$$

2. Give a rule for finding the decimal point in dividing one decimal by another. Divide ·378 by 262·5, and 37·8 by ·0002625.

Rule: Subtract the number of decimal places in the divisor from the number in the dividend, and mark off the difference in the quotient. If the number in the divisor exceeds the number in the dividend add 0's till they are equal, and then subtract.

262·5)·378000(·00144. Ans.
2625
11550
10500
10500
10500

·0002625)37·8000000(144000. Ans.
2625
11550
10500
10500
10500
000

3. What decimal of a guinea is equal ·36 of 13s. 8½d.?

$$\frac{\text{·36 of 13s. 8½d.}}{\text{1 guinea}}$$

$$= \frac{\frac{36}{100} \times \frac{273}{2}}{504}$$

$$= \frac{36}{100} \times \frac{273}{2} \times \frac{1}{504}$$

$$= \frac{273}{2800}$$

$$= \text{·}2\frac{73}{}. \text{ Ans.}$$

4. A boy loses ⅓ of his money and then gains 6d.; he then loses ¼ of what he has and gains 4d.; he afterwards loses ⅖ of what he has, and he finds he has 2s. 1d. left. How much had he at first?

2s. 1d. = ⅗ of money before last loss.

$\therefore \frac{3}{5} = \frac{25 \times 8}{5} = 40\text{d.}$

40d. = 4d. + ¾ of money before second loss.

$\therefore \frac{3}{4} = \frac{36 \times 3}{2} = 54\text{d.}$

54d. = 6d. + ⅔ of money before first loss.

$\therefore \frac{2}{3} = \frac{48 \times 4}{3} = 64\text{d.}$

$\therefore$ 5s. 4d. = Money at first. Ans.

FEMALES.

1. Find the cost of 796 articles at £13 14s. 3½d. each.

	£	s.	d.	
10s. = ½ of a £	796	0	0	= Value of 796 arts. at £1 each.
	13			
	10348	0	0	= ,, ,, at £13 each
4s. = ⅕ of a £	398	0	0	= ,, ,, ,, 10s. ,,
3d. = 1/80 of 4s.	159	4	0	= ,, ,, ,, 4s. ,,
½d. = ⅙ of 3d.	9	19	0	= ,, ,, ,, 3d. ,,
	1	13	2	= ,, ,, ,, ½d. ,,
	£10.916	16	2	= £13 14s. 3½d. Ans.

2. How much must be given for 84 cwt. 3 qrs. 14 lbs. at £12 11s. 8d. per cwt.?

	£	s.	d.	
2 qrs. = ½ of 1 cwt.	12	11	8	= Value of 1 cwt.
	84			
	1057	0	0	= ,, 84 cwt.
1 qr. = ¼ of 2 qrs.	6	5	10	= ,, 2 qrs.
14 lbs. = ¼ of 1 qr.	3	2	11	= ,, 1 qr.
	1	11	5½	= ,, 14 lbs.
	£1068	0	2½	= 84 cwt. 3 qrs. 14 lbs. Ans.

3. What is the least number of soldiers that can be divided into companies of 16, 30, 48, 56, and 72?

6 | 16, 30, 48, 56, 72
4 | 5, 8, 56, 12
5 14 3

6 × 4 × 5 × 14 × 3 = 5040. Ans.

4. How much change shall I have out of a £10 note after paying the following bill?

15½ yards flannel at 2s. 3d. per yd.
29 yds. calico at 8½d. per yd.
25 yds. Irish linen at 2s. 4d. per yd.
17 yds. towelling at 1s. 2d. per yd.
12½ yds. brown holland at 11½d. per yd.
3½ doz. handkerchiefs at 9s. 10d. a doz.

		£	s.	d.
15½ yds. flannel at 2s. 3d.	... per yd. =	1	14	10½
29 yds. calico at 8½d. ...	... ,, =	1	0	6½
25 yds. Irish linen at 2s. 4d.	... ,, =	2	18	4
17 yds. towelling at 1s. 2d.	... ,, =	0	19	10
12½ yds. brown holland at 11½d.	... ,, =	0	11	11½
3½ doz. handkerchiefs at 9s. 10d.	per doz. =	1	14	5
		£8	19	11½

£10 − £8 19s. 11½d. = £1 0s. 0½d. Ans.

Grammar.

MALES AND FEMALES.

1. Parse the sentence—

He needs strong arms who swims against the tide.

He—pers. pro., masc. gen., sing. no., 3rd per., nom. to *needs*.
needs—reg. trans. verb, act. voice, ind. mood, pres. tense, 3rd per., sing. no., agreeing with its nom. *he*.
strong—adj. of quality, qualifying *arms*.
arms—com. noun, neut. gen., plur. no., obj. case, gov. by *needs*.
who—rel. pro., masc. gen., sing. no., 3rd per., agreeing with antecedent *he* and nom. to *swims*.
swims—irreg. intrans. verb, act. voice, ind. mood, pres. tense, 3rd per., sing. no., agreeing with its nom. *who*.
against—preposition, showing reln. bet. *tide* and *swims*.
the—dist. adj., limiting *tide*.
tide—com. noun, neut. gen., sing. no., obj. case, gov. by *against*.

2. Say how many sentences there are in this verse, and what is the subject and predicate of each—

Sweet bird! thy bower is ever green,
Thy sky is ever clear;
Thou hast no sorrow in thy song,
No winter in thy year.

Four.

Subject.	*Predicate.*
(1) Thy bower	is green
(2) Thy sky	is clear
(3) Thou	hast
(4) [Thou]	[hast]

3. Explain what is meant by a participle, and give examples.

A participle is that part of a verb which partakes of the nature of a verb and an adjective. Examples.—

Verb.	*Adjective.*
The sun is *shining*	The *shining* sun
The general was *defeated*	The *defeated* general

4. Show the meaning of the final syllable in each of the following words, and give other examples of words of the same formation:—

Oxen. Golden. Darken. Bounden. Duckling. Streamlet. Readable. Singer. Peaceful. Faithless.

Word.	Syllable	Meaning.	Other Words.
Oxen	en	Plural ending	Brethren, children: O.E., een (eyes) been (bees)
Golden	en	made of	wooden, flaxen, linen
Darken	en	to make (sign of Infinitive)	gladden, hearken
Bounden	en	to make (participial form)	molten, drunken
Duckling	ling	little (a diminutive)	gosling, darling, foundling
Streamlet	let	little	rivulet, leaflet, brooklet
Readable	ble	that which may be	eatable, drinkable, bearable
Singer	er	the person who acts	player, reader, painter
Peaceful	ful	full of	sorrowful, mournful, awful
Faithless	less	without	houseless, homeless, breathless

Geography.

(Answer either Q. 1 or Q. 2; not both.)

1. Draw a map of the West Coast of Scotland from Ardnamurchan Point to the Firth of Clyde, with the names of the islands and inlets.

2. Give an account of the mountain system of Ireland.

The mountains of Ireland consist of isolated ranges near the coast, forming a broken circle round the island, and enclosing the great central plain.

None of the mountains rise to a great height, Carran Tual (3,404 ft.) in Macgillicuddy's Reeks, Kerry, being the highest.

The chief ranges are the Mourne Mountains in Down, the Mountains of Antrim, Donegal, and Mayo; the Connemara Mountains, stretching from Clew Bay to Galway Bay; Clare Mountains; Mount Brandon, near Tralee Bay; Macgillicuddy's Reeks in Kerry; Galtee Mountains, and Knockmeledown Mountains in Tipperary and Waterford, and the Wicklow Mountains. There is one range in the interior, the Slieve Bloom Mountains, which separates the basin of the Levem from that of the Barrow and Suir. The hills are cultivated often to the summit.

3. Describe the rivers of Australia.

Australia has fewer rivers than either of the other continents, and of those which are known, only the Murray is navigable to any great extent. Parallel with the eastern coast runs a range of mountains known by different names. This range is the source of the Murray, which flows in a south-westerly direction, with many windings, for nearly 2,000 miles, entering the sea at Encounter Bay, in South Australia. Its tributaries are the Lachlan, Darling, and Murrumbidgee.

The interior of Australia, so far as is known, is entirely destitute of streams, and the only other rivers are the Hunter, in New South Wales; the Brisbane, in Queensland; the Albert, flowing into the Gulf of Carpentaria; the Adelaide, into Van Diemen's Gulf; and the Swan River in Western Australia.

History.

1. 'The true conqueror of Britain was Julius Agricola.' Explain this statement, and tell the limits of his sway in the British Islands.

Although a great part of England had been subdued between 43 and 78 A.D., the people were not actually conquered, and no sooner were the Roman forces removed than the Britons resumed their sway. When Julius Agricola came as Governor, he not only conquered the country, but by his clemency he caused the people to like the Romans. He encouraged them to build temples, courts of justice, and better houses for themselves, to wear the Roman dress, and adopt the ways and manners of the Romans. In this way he may be said to have been the real conqueror of Britain. He reconquered Anglesea, and extended his sway during the seven years he was Governor throughout the whole of the North of England and the South of Scotland to the Forth and Clyde, in one campaign going even to the Grampians. He built two lines of forts, from the Tyne to the Solway, and from the Forth to the Clyde. His ships also circumnavigated the island.

2. What parts of this country were settled by the Jutes, Angles, and Saxons respectively? Name some of the kingdoms set up by them.

The *Jutes* were the first Teuton invaders of England. They came in 450 on the invitation of Vortigern, who gave them the Isle of Thanet. After quarrels and wars with the Britons they founded the *Kingdom of Kent*.

The second settlement (477) was made by the *Saxons*, under Ella, in Sussex, and afterwards Surrey. This was known as the Kingdom of the *South Saxons*.

The *West Saxon* Kingdom (Wessex) included Hampshire and Dorsetshire, and was formed by Cerdic and his sons (495-514).

Another body of Saxons occupied Middlesex and Essex in 527. They were the East Saxons.

The Kingdom of *East Angtia* was founded by the Angles in the sixth century. It included Norfolk, Suffolk, Cambridge, and Huntingdon. The Angles also founded Northumbria in 617.

Mercia was founded by the Angles, under Cridda, in 582.

3. Who was Earl Godwin? Which of our kings was he connected with?

Earl Godwin was an Englishman whom Canute placed over Wessex, one of the five earldoms into which he divided the country, and to whom he gave Gytha, a Danish lady belonging to the family of Canute, in marriage.

Godwin assisted *Harold*, and afterwards *Hardicanute*, to the throne of England. His daughter Edith subsequently married *Edward the Confessor*. His son *Harold* was, on the death of Edward, chosen as the king of England.

Composition.

Write from memory the substance of the passage read to you by the Inspector.

The passage was as follows:—

In Sierra Leone, on occasion of a violent tropical storm, two native people, a man and a woman, were engaged at the door of their hut, singing, beating drums, and offering up their adorations and prayers to the lightning. Suddenly a loud shriek took the place of the votive song. The hut of the miserable pair was struck by the fluid which they were worshipping, and they were buried in the ruins. Next day they were found, blackened, distorted, and putrefying, by the officers of an English expedition who had witnessed the catastrophe. But it appeared that the countrymen of the victims regarded their death as an especial mark of the favour of their gods, who had translated them to heaven by the agency of the sacred fluid, the object of their worship.

FEMALES.

Needlework.

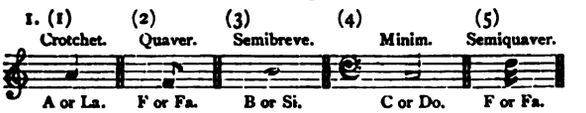
One hour will be allowed for this exercise in the afternoon.

Music.

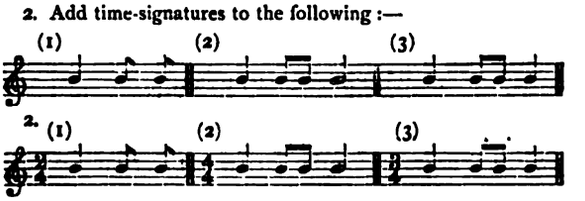
A quarter of an hour allowed for this paper.

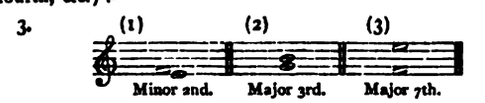
(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write above each of the following notes its value-name (semibreve, &c.), and below each its pitch-name:—



2. Add time-signatures to the following:—



3. Write below each of the following intervals its name (major fourth, &c.):—

TONIC SOL-FA NOTATION.

1. Write (1) a six-pulse tone, using two-pulse measure; and (2) a six-pulse tone, using three-pulse measure.

1. |1 :— |— :— |— :— ‖

|1 :— :— |— :— :— ‖

2. Write the names of the following intervals:—(1) *me* to *fah*; (2) *soh* to *te*; (3) *fah* to *me'*.

2. (1) Minor second; (2) major third; (3) major seventh.

3. Write the following an octave higher, and state what is meant by the direction "Key G":—

Key G.

|d	:s	|m	:f	|s	:l	|r	:s	|m	:—	‖
3. |d'	:s'	|m'	:f'	|s'	:l'	|r'	:s'	|m'	:—	‖

"Key G" means that *doh* is to be fixed to the sound of the scale called G.

SECOND YEAR.

Pupil Teachers at end of Second Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

1. If two triangles have two sides of the one equal to two sides of the other, each to each, and have likewise their bases equal; the angle which is contained by the two sides of the one shall be equal to the angle contained by the two sides equal to them of the other.

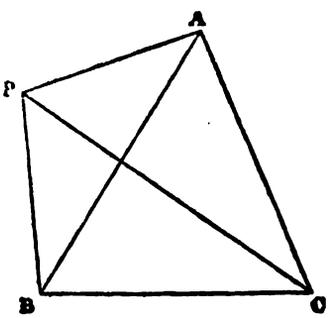
Euclid, Book I., Prop. 8.

2. To make a triangle of which the sides shall be equal to three given straight lines, but any two whatever of these must be greater than the third.

Euclid, Book I., Prop. 22.

3. P is a given point, ABC a given triangle; show that the sum of PA, PB, PC is greater than half the sum of the sides.

Let P be the given point, and ABC the given triangle. Join PA, PB, and PC.



Because any two sides of a triangle are together greater than the third side,

∴ PA, PB are greater than AB,
PA, PC are greater than AC,
PB, PC are greater than BC,
∴ twice PA, PB, PC are greater than AB, AC, BC,
and PA, PB, PC are together greater than half AB, AC, BC.
Q.E.D.

Arithmetic.

FEMALES.

1. Find the least fraction which added to the sum of $\frac{1}{7}$, $\frac{8}{15}$, and $\frac{23}{28}$ will make the result an integer.

$$\frac{1}{7}+\frac{8}{15}+2\frac{23}{28}$$
$$=2\frac{105+108+50}{120}$$
$$=4\frac{23}{120}$$
∴ Least fraction $=5-4\frac{23}{120}=\underline{\frac{97}{120}}$. Ans.

2. What fraction of a ton added to $\frac{11}{12}$ of 2 cwt. will make it equal to 1 cwt. 2 qrs. 11 lbs.?

1 cwt. 2 qrs. 11 lbs. $-\frac{11}{12}$ of 2 cwt.
$$=1\tfrac{9}{112}-\tfrac{11}{6}$$
$$=\frac{179-88}{112}$$
$$=\tfrac{91}{112}\text{ cwt.}$$
$$=\underline{\tfrac{13}{112}\text{ ton.}}\text{ Ans.}$$

3. Express as decimal fractions $\frac{27}{200}$ and $\frac{13}{150}$.

$\frac{27}{200}=\frac{135}{1000}=\underline{\cdot135}$. Ans.

$\frac{13}{150}=\frac{1}{10}=\underline{\cdot1}$. Ans.

4. Out of a cask two-thirds full eight gallons are drawn, and it is then found to be two gallons less than half full. How many gallons is the cask able to hold?

$\frac{2}{3}-\frac{1}{2}=\frac{1}{6}$.
$\frac{1}{6}$ of the cask holds 6 gallons.
∴ The cask holds $6\times6=\underline{36\text{ gallons.}}$ Ans.

Grammar.

MALES AND FEMALES.

1. Show how many separate sentences there are in the following extract, and what are the parts of each:—

O dread and silent mount! I gazed upon thee
Till thou, still present to the bodily sense,
Didst vanish from my thought: Entranced in prayer
I worshipped the Invisible alone.

—COLERIDGE.

ANALYSIS.

Sentence.	Kind of Sentence.	Conn.	Subject.	Predicate.	Object.	Exten.
(*a*) I gazed upon thee	Principal Sentence.		I	gazed		upon thee (place)
(*b*) till thou, still present to the bodily sense, didst vanish from my thoughts.	Adv. Sent. (time) to *a*.	till	thou still present to the bodily sense	didst vanish		from my thought (place)
(*c*) Entranced in prayer I worshipped the Invisible alone	Principal Sentence.		I, entranced in prayer,	worshipped	the Invisible alone	

2. How would you explain and illustrate to a class the meaning and use of each of the following grammatical terms:—

Relative. Imperative. Potential. Passive. Intransitive. Irregular.

Relative.—Pronouns are called *Relative* when they refer to, and stand for, some noun or pronoun which has been used before, such noun or pronoun being called the *Antecedent*. Illustration: The boys were talking of the holiday *which* had been promised them. Here *which* stands for holiday, and reference must be made to *holiday* in order to determine what *which* means.

Imperative.—A word used to describe the form of the verb which is used when a command is given; as: *Go* home. When used thus, *go* expresses a command, and the verb is said to be in the Imperative Mood.

Potential.—A mood of verbs expressing power, permission, will, or necessity, as: I *may* go; I *can* ride; I *must* walk.

Passive.—When the form of the verb signifies that the person or thing spoken of (the nominative case) does not act, but is acted upon, the verb is said to be in the Passive Voice, as, The house *was built*.

Intransitive.—Some verbs are complete in themselves, and do not need an object to be stated to complete the the sense. Such verbs are called *Intransitive*. Ex. Birds *fly*. Lions *roar*.

Irregular.—Many verbs form their past tense and past participle in one regular way, by adding *d* or *ed* to the present tense. Those which do not are called *Irregular* verbs, as, Sing, sang, sung.

3. Make a list of five words commencing with each of the following syllables, and explain the meaning of each word, showing the full force of the prefix:—

e. con. a. ob. re. inter.

e:—*educe*, to lead or draw *out*; *evade*, to go *away* or escape *from*; *elapse*, to slip or glide *away from*; *elect*, to choose *out*; *emit*, to send *out*.

con :—*connect*, to knit or fasten *together*; *confine*, to keep *together* within bounds; *conduce*, to conduct or lead *together* or towards the same end; *conjure*, to unite *together* by an oath; *conjoin*, to join *together*.

a :—*avert*, to turn *from* or *away*; *abed*, *in* or *on* the bed; *afar*, *at* a far distance; *ahead*, *on* head, *in* front; *asleep*, *on* or *to* sleep.

ob :—*obstruct*, to build *in the way of*; *object*, to throw *in the way of*; *observe*, to keep *in view*; *obviate*, to meet *in the way of*; *obtain*, to lay hold of.

re :—*repay*, to pay *back*; *retain*, to keep *back*; *reply*, to say *again* as an answer; *remove*, to move *back* or *away*; *renew*, to make new *again*.

inter :—*intercede*, to go *between* two as a mediator; *interfere*, to strike *between*; *interject*, to throw *in* or *between*; *interlay*, to lay *among* or *between*; *interpose*, to place *between*.

Geography.

1. Draw a map of Spain, marking the mountains and rivers.

2. Describe the principal rivers of British India.

The three largest rivers of India are the Ganges, Indus, and Brahmapootra.

The Ganges rises on the northern side of the Himalayas, in a cave 11,000 feet above the sea-level, flows through the chain for 200 miles, descending in that distance nearly 10,000 feet. On entering the plain of India, at Hurdwar, it flows in a south-easterly direction for 500 miles more, and finally southward for 300 miles, into the Bay of Bengal, entering by many mouths, branches having been formed 200 miles from the sea. It receives as tributaries, the Goomtee, Gogra, and Gunduck, on the left bank and Jumna (600 miles), and Sone on the right bank.

The Indus is nearly 1800 miles in length. It rises in the Himalayas, flows west and then south-west through the mountains, entering the plain at Attock. Then it receives the Cabul on the right, and Chenab and its tributaries, Ravee, Beas, Sutlej, on the left. Its course is more rapid, and its waters much more abundant than those of the Ganges. It enters the Arabian Sea to the west of India.

The Brahmapootra rises in the Himalayas, flowing east and then south, to join the Ganges, ere it enters the Bay of Bengal. Its course is almost as long as that of the Ganges.

The Taptee (450 miles), and the Nerbudda (800 miles), are two rivers of the Deccan, which flow westward, and the Mahanuddy (520), Godavery (600), Kistnal (800), which flow eastward, drain the same great tableland.

3. What are the climate and principal exports of the Dominion of Canada?

The climate of the Dominion of Canada is varied, because of the great extent of latitude covered by the country. Great extremes of heat and cold are felt, but the cold is less thought of, on account of the absence of wind and fog. The winter lasts from four to eight months, according to latitude, and is much more severe in the Eastern than in the Western part of the Dominion. The great lakes serve to modify both the cold of winter and the heat of summer. It is very healthy.

The chief exports of the Dominion are timber in its various forms, potash and pearlash, wheat, flour, cattle, beef, skins, and fish.

SECOND PAPER.

Two hours and a half allowed.

FEMALES.

Needlework.

The needlework specimens will be collected by the Inspector at the expiration of an hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. A man walks 10 miles in 3 hours, then 12 miles in 3½ hours, and then 13 miles in 4 hours. What is his average rate of walking per hour?

Total miles walked = 10 + 12 + 13 = 35 miles.
,, hours ,, = 3 + 3½ + 4 = 10½ hrs.
No. miles walked per hour = 35 ÷ 10½ = 3⅓. Ans.

2. In what time will £875 12s. 6d. amount to £1,013 10s. 8½d. at 4½ per cent. per annum simple interest?

Total interest = £1013 10 8½ − £875 12 6 = £137 18 2½.

$$\text{Int. for 1 year} = \frac{£875\ 12s.\ 6d. \times 4}{100} = £39\ 8s.\ 0\tfrac{1}{2}d.$$

$$\text{No. of years} = \frac{£137\ 18s.\ 2\tfrac{1}{2}d.}{£39\ 8s.\ 0\tfrac{1}{2}d.} = 3\tfrac{1}{2}.\quad \text{Ans.}$$

3. If by investing £2,145 in 5 per cent. railway debentures I get £82 10s. in dividend, what must be the price of the debentures, the usual brokerage being charged?

If the price per cent. were £100, the yield would be

$$\frac{2145 \times 5}{100} = £107\ 5s.$$

£ s. £ s. £ £
∴ 82 10 : 107 5 :: 100 : 130
130 − ½ = 129½. Ans.

4. If a woman buys eggs at 10d. a dozen, how many ought she to sell for 9d. in order to gain 8 per cent.?

Price per dozen to gain 8 per cent. =
d. d.
100 : 108 :: 10 : 10⅘
No. to be sold for 9d. to gain 8 per cent. =
d. d. eggs eggs
10⅘ : 9 :: 12 : 10. Ans.

History.

MALES.

1. What change of language and law followed the Norman Conquest?

French was the language of the Normans. When England was conquered by William, French became the language of the court, of the nobility (both French and English), and of the inferior clergy. Any literature that existed was written in French. French was spoken in the courts of law, in the universities, in parliament, and all the schools attached to the cathedrals and churches, and many of the country people spoke French in order that they might be the more thought of.

The chief changes in the law were in respect of land and game. Instead of the freedom of the Saxon times the Feudal System was introduced, by which each holder of land from the sovereign swore fealty to the king. Subsequently each subvassal also took the oath of fealty to the sovereign. By the Forest Laws game was strictly preserved, severe penalties being inflicted on all who were found hunting in the royal forests.

A justiciar or king's deputy exercised full power in the king's absence, and the Curfew Bell being rung restricted still further the freedom of the people.

2. How did Normandy become a foreign province of England? Do we still hold any portions of it?

William the Conqueror was Duke of Normandy, and retained possession of the Duchy while King of England. On his death it passed to Robert his eldest son, and at the battle of Tenchebrai it again became a fief of the English crown. Henry's daughter kept it while Stephen was king, but when Henry II. ascended the throne he ruled Normandy as well as England. The sovereignty of the Duchy was claimed by each king till the reign of Henry VI., when nearly all the possessions of England in France were lost.

The Channel or Norman Isles were part of the duchy, and have been retained by this country since the Conquest.

3. When and where did John die? Describe the condition of the country at that time.

John died on the 19th of October, 1216, in the Castle of Newark, after his jewels and treasures had been lost while crossing the Wash.

The country at the time of his death was in a state of insurrection. He had violated the Charter which he had sworn to keep, by obtaining a papal bull annulling it, and by over-running the country with a band of mercenaries. The barons threw off their allegiance and offered the crown to Louis, the son of the King of France. Louis came to London and received their homage. John collected his forces in Lincolnshire, while Louis besieged Dover.

This was the state of affairs when the accident happened which resulted in John's death.

Teaching.

Give some examples of different kinds of mental exercise in arithmetic suited for children in the Second Standard.

Examples in the simple rules, separate and combined :—

$7+4+9+20$; $9+5+4+12$;
$17-10+7-4$; $15+5+20-30$;
$9\times8+4$; $11\times11-1$; $10\times12+16$;
$36\div4\times9$; $72\times2\div12$.

In Money :—

Pence in 4s. ; 5s. ; 6s. ; 8s. ; 10s. ; 12s.
,, 3s. 6d. ; 4s. 2d. ; 5s. 7d. ; 8s. 1d. ; 9s. 2d.
Farthings in 4½d. ; 5¾d. ; 8¼d. ; 1s. 0¾d.
,, 1s. ; 1s. 6d. ; 2s. ; 2s. 6d.

A boy steps 18 inches at a time; how many in 5 steps?
A chicken costs 10d. ; how many shillings for 6 chickens?
Five pairs of boots cost 50s. ; what will one pair cost?
Two? Three? Four?
Add 4½d. and 5¼d. ; take 7½d. from 1s. ; 11½d. from 1s. 1d.

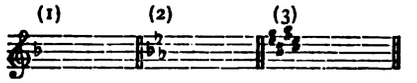
Music.

A quarter of an hour allowed for this paper.

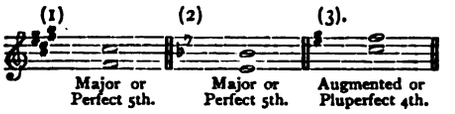
(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

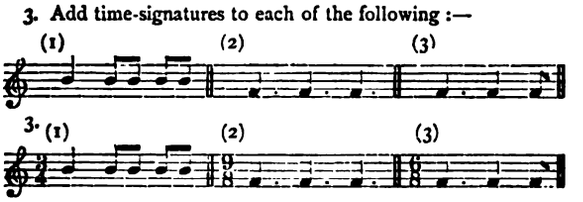
1. Write the key-signature of each of the following major keys :—(1) of F ; (2) of E♭ ; (3) of E.

1. (1) (2) (3)

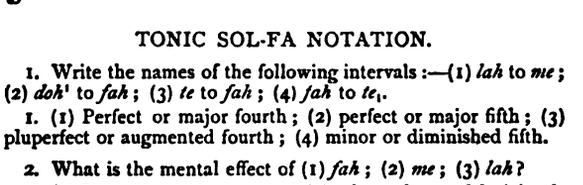


2. Write below each of the following intervals its name (major second, &c.) :—

2. (1) (2) (3).

3. Add time-signatures to each of the following :—



3. (1) (2) (3)



TONIC SOL-FA NOTATION.

1. Write the names of the following intervals :—(1) *lah* to *me* ; (2) *doh'* to *fah* ; (3) *te* to *fah* ; (4) *fah* to te_1.

1. (1) Perfect or major fourth ; (2) perfect or major fifth ; (3) pluperfect or augmented fourth ; (4) minor or diminished fifth.

2. What is the mental effect of (1) *fah* ; (2) *me* ; (3) *lah*?

2. (1) Serious, grave, expectant; (2) calm and peaceful; (3) sad.

3. What are the five kinds of measure most commonly used?

3. Two, three, four, six, and nine-pulse.

THIRD YEAR.

Pupil Teachers at end of Third Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including No. 3, if you can.

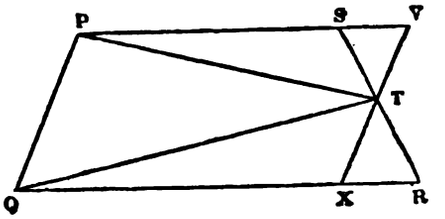
1. If two triangles have two sides of the one equal to two sides of the other, each to each, but the angle contained by the two sides of one of them greater than the angle contained by the two sides equal to them, of the other; the base of that which has the greater angle shall be greater than the base of the other.

Euclid : Book I., Prop. 24.

2. If the square described upon one of the sides of a triangle, be equal to the squares described upon the other two sides of it; the angle contained by these two sides is a right angle.

Euclid : Book I., Prop. 47.

3. PQRS is a quadrilateral having QR parallel to PS, T is the middle point of SR; show that the triangle PQT is half the quadrilateral.



Let PQRS be the given quadrilateral, and T the middle point of RS.

Through T draw XV parallel to PQ and meeting PS in V.

Then ∠ VST = ∠ TRX (I. 29) ; ∠ STV = ∠ XTR (I. 15), and side ST = side TR, ∴ △ STV = △ TXR (I. 26).

Add to each PQXS. Then quadrilateral PQRS = parallelogram PQXV, and △ PQT = half parallelogram PQXV, because they are upon the same base PQ and between the same parallels PQ and XV.

∴ △ PQT = half the quadrilateral PQRS.

Q. E. D.

Algebra.

(Answer two Questions, including No. 2, if you can.)

1. Simplify $9(3x-a)(3x+a)-7(2x+a)^2+3(2x-3a)(x+4a)$

$9(3x-a)(3x+a)-7(2x+a)^2+3(2x-3a)(x+4a)$
$=9(9x^2-a^2)-7(4x^2+4xa+a^2)+3(2x^2+5xa-12a^2)$
$=81x^2-9a^2-28x^2-28xa-7a^2+6x^2+15xa-36a^2$
$=59x^2-13xa-52a^2$. Ans.

2. Prove the rule for finding the L. C. M. of two expressions.

Find it for x^2-4, x^3+8, $2x^2+3x-2$, and $2x^2-3x-2$.

Let A and B denote two expressions, and C their common measure. Let $A=pC$ and $B=qC$. Then since C = the G. C. M. of pC and qC, p and q have no common factor, and the least number which will contain p and q, that is, their least common multiple, is pq. ∴ the least common multiple of pC and qC is pqC.

And $pqC = Aq = Bp = \frac{AB}{C}$

$x+2 \mid x^2-4,\ x^3+8,\quad 2x^2+3x-2,\ 2x^2-3x-2$
$x-2 \mid x-2,\ x^2-2x+4,\ 2x-1,\quad 2x^2-3x-2$
$x^2-2x+4,\ 2x-1,\quad 2x+1$

L. C. M. = $(x^2-4)(x^2-2x+4)(4x^2-1)$. Ans.

3. Solve the equations :—

(1) $\frac{2x-\frac{1}{2}}{2}-\frac{2x-\frac{2}{3}}{5}=\frac{4x}{13}$

(2) $\frac{x-1}{x+3}-\frac{2x-1}{3x+1}=\frac{1}{3}$

(1) $\frac{2x-\frac{1}{2}}{2}-\frac{2x-\frac{2}{3}}{5}=\frac{4x}{13}$

$130x-39\frac{1}{2}-52x+39=40x$

$38x=162\frac{1}{2}-39$

$38x=123\frac{1}{2}$

$x=3\frac{1}{4}$. Ans.

(2) $\frac{x-1}{x+3}-\frac{2x-1}{3x+1}=\frac{1}{3}$

$$3(3x^2-2x-1)-3(2x^2+5x-3)=3x^2+10x+3$$
$$9x^2-6x-3-6x^2-15x+9=3x^2+10x+3$$
$$-31x=-3$$
$$x=\frac{3}{31}. \quad \text{Ans.}$$

Mensuration.

A room is 15 feet long, 10 broad, and 9¾ high. Find the cost of painting the walls and the ceiling at 1s. 9d. per sq. yd.

Length of walls $=(15+10)2=50$ feet
Area of walls $=50\times 9\frac{3}{4}=487\frac{1}{2}$ sq. feet
,, ceiling $=10\times 15=150$ sq. ft.
Total area $=(487\frac{1}{2}+150)=637\frac{1}{2}$ ft. $=70$ sq. yd. $7\frac{1}{2}$ ft.
Cost = 1s. 9d. × 70½ = £6 3s. 11½d. Ans.

Arithmetic.

FEMALES.

Add together £·0375, ·625s., ·75d., and 3s. 3·5d., and reduce the sum to the decimal of 7s. 6d.

	s.	d.
£·0375 = ·75s.	= 0	9
·625s. = 7·5d.	= 0	7½
·75d. = 3f.	= 0	¾
3s. 3·5d. =	= 3	3½
	4	8¾

$$\frac{4\text{s. } 8\frac{3}{4}\text{d.}}{7\text{s. } 6\text{d.}}=\frac{35}{90}=\frac{7}{18}=\underline{\cdot 6305}. \quad \text{Ans.}$$

2. The circumference of a circle is 3·14159 times its diameter; find the length of the diameter of a circle whose circumference is 13 yds. 2 ft. 7¾ in. (Work to 4 places of decimals only)

yds.	ft.	in.
13	2	7¾
	3	
	41	
	12	in.

3·14159)499·75(159·0754+
$=4$ yds. 1 ft. 3·0754 + ins. Ans.

3. A bankrupt having £645 5s. 3½d. left, can pay 7s. 8½d. in the £; what is the amount of his debts?

s.	d.	£		s.	d.	£	£	s.	d.
7	8½	: 645	5	3½	:: 1 :		1674	4	0. Ans.

4. Simplify $\frac{(3\cdot2-2\cdot9)\times 147}{\cdot003\times\cdot0005}$.

$$\frac{(3\cdot2-2\cdot9)\times 147}{\cdot003\times\cdot0005}$$
$$=\frac{\cdot3\times 147}{\cdot003\times\cdot0005}$$
$$=\frac{100\times 147}{\cdot0005}$$
$$=\frac{20\times 147}{\cdot0001}$$
$$=200000\times 147$$
$$=29{,}400{,}000. \quad \text{Ans.}$$

Grammar.

MALES AND FEMALES.

Analyse this sentence :—

'If a man be bird-witted, that is, quickly carried away, and hath not the patient faculty of attention, let him study the mathematics; wherein, if the wit wander, the demonstration must be renewed.'

BACON.

ANALYSIS.

Sentence.	Kind of Sentence.	Connective.	Subject.	Predicate.	Object.	Extensn. of Pred.
(a) If a man be bird-witted	Adv. (cond.) to e	If	a man	be bird-witted		
(b) that is	Princ. sent.		that	is		
(c) quickly carried away	Adv. (cond.) to e	if	[a man]	[be] carried		quickly away
(d) and hath not the patient faculty of attention	Adv. (cond.) to e	if	[a man]	hath	the patient faculty of attention	not
(e) let him study the mathematics	Princ. sent.		[thou]	let	him [to] study the mathematics	
(f) wherein the demonstration must be renewed	Adj. sent. to mathematics in e	where in	the demonstration	must be renewed		
(g) if the wit wander	Adv. (cond.) to f	if	the wit	wander		

2. Explain in your own words the meaning of the above passage.

The best remedy for a man who finds it difficult to fix his attention fully upon the matter he has in hand, who finds that whenever he commences to work his mind begins to wander first to one thing and then another, like a bird flies from branch to branch, is to apply himself to that branch of science called Mathematics, because in it he will find that if he does not pay the strictest heed he will be compelled to begin the work anew, and to do it over and over again.

3. Show what is the precise meaning of the prefix in each of the following words. Say from what language it is derived, and give in each case another word similarly formed :—

Improper, Impose, Amphibious, Unclean, Recover, Reform, Conceal, Contradict, Behave, Sympathy, Antedate, Antithesis.

Word.	Prefix.	Meaning.	Source.	Other Word.
Improper	im-	not	Latin	improbable
Impose	im-	upon	,,	imprecate
Amphibious	amphi-	both	Greek	amphitheatre
Unclean	un-	not	Saxon	unkind
Recover	re-	back	Latin	remove
Reform	re-	again	,,	receive
Conceal	con-	altogether, or completeness	,,	concave
Contradict	contra-	against	,,	contravene
Behave	be-	sign of infinitive	Saxon	behead
Sympathy	sym-	with	Greek	symmetry
Antedate	ante-	before	Latin	antemeridian
Antithesis	anti-	against	Greek	anti-climax

4. 'What' is said to be a compound relative. Explain this, and give four or five examples of sentences in which the word occurs, and in which its case would require to be specially made plain to a class of learners.

A relative pronoun stands for a noun or pronoun which has gone before it, and generally connects a subordinate sentence to a principal sentence. Sometimes, however, the noun is not stated, but is understood as being contained in the word *what*. It is in this way that 'what' is called a compound relative, because it stands for the antecedent and for the relative as well.

Examples requiring explanation :—

I have what I require.
This is what he wants.
He hath well-fortified what he hath won.
Tell me what they seek.
What is one man's meat is another man's poison.

Geography.

1. Draw a map of the Coast of Africa from the Orange River to the mouth of the Zambesi.

2. What are Constant, Periodical, and Variable Winds? Give examples of each.

Constant Winds are such as constantly blow in the same direction. The Trade Winds and the Polar Winds are examples.

Periodical Winds are those which blow for certain periods of the year, or at certain times and seasons, as, the Monsoons, and the Land and Sea Breezes.

Variable Winds are those which blow at no fixed period. Variable Winds are common in all temperate regions.

3. State the positions and give some account of the lakes of Asia.

The Caspian Sea (750 miles by 200 miles) and the Sea of Ural (265 miles by 125 miles) are great salt-water lakes of Asia lying to the South of the Ural Mountains, the Caspian Sea being much below the level of the ocean. They have no outlets.

The largest fresh-water lake of Asia is Lake Baikal, in the same latitude as England, and in longitude 104° to 111° E. It is 400 miles long, from 20 to 50 miles broad, and in many places very deep. It receives many streams, the Lelinga and the Angara being the largest.

There are several lakes in Western Asia, but they are not very large. Balkash, near the north of the great central depression of Asia, is 150 miles long and 75 broad, but has no outlet. Tehany, in Siberia; Urumiyah, in Persia; Van, in Armenia, are salt-water lakes. Pangong, in Thibet, and Sir-i-Kol are noted, the one for its connection with the Indus, and the other as being the highest known lake in the world.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. If a dealer by selling a horse for £34 4s. lost 5 per cent., what per cent. would he gain or lose by selling it for £39 12s.?

£34 4s. represents the value − 5 per cent.
= 100 − 5 = 95.

£ s.	£ s.	£	£
∴ 34 4	: 39 12	:: 95	: 110

Gain = 110 − 100 = 10 per cent. Ans.

2. Find, in decimals, the value of $\sqrt{1\frac{45}{121}} - \sqrt{\frac{1}{9}}$.

$$\sqrt{1\tfrac{45}{121}} - \sqrt{\tfrac{1}{9}}$$
$$= \sqrt{\tfrac{169}{121}} - \sqrt{\tfrac{1}{9}}$$
$$= \tfrac{13}{11} - \tfrac{1}{3}$$
$$= \frac{39 - 11}{33}$$
$$= \tfrac{28}{33}$$
$$= .84 \text{ Ans.}$$

3. A person invested £5245 10s. in the 3½ per cents. at 100¾, and the stocks falling he sold out on the same day at par. How much did he lose, brokerage being charged on each transaction?

He paid 100¾ + ¼ = 101
He sold for 100 − ¼ = 99¾
∴ Loss on 100¼ = 1
,, 5245½ = $\frac{1 \times 5245\frac{1}{2}}{100\frac{1}{4}}$ = £52. Ans.

4. The true present worth of a bill of £347 12s. 6d. due 8 months hence is £337 10s. Find the rate of interest per cent. per annum.

Total interest for 8 months =
£347 12s. 6d. − £337 10s. = £10 2s. 6d.

£	£	£	£
∴ 337½	: 100	:: 10⅛	: 4½ per cent. Ans.
months 8		12	

History.

MALES AND FEMALES.

1. Who were the Stuarts? What was their general attitude towards Parliament?

The Stuarts were the descendants of Henry VII., king of England, through his daughter Margaret. After the death of James IV. of Scotland, to whom she was married, Margaret married Archibald Douglas, by whom she had a daughter, Margaret, who married Matthew Stuart, Earl of Lennox. Lord Darnley, their son, married Mary, grand-daughter of James the Fourth, and their son, James the Sixth of Scotland, became James I. of England.

The general attitude of the House of Stuart was one of hostility to the Parliament. James I. and Charles I. were both strong advocates of the Divine right of kings. The Parliament represented the popular aspirations after freedom and liberty. The result was that the kings and Parliament were frequently in conflict, Charles I. being beheaded, and James II. being deposed.

2. What was Ship Money? Explain John Hampden's objection to pay it.

During the time of Elizabeth, the maritime counties had been called upon to furnish ships for the nation in time of war. When striving to carry on the Government without a Parliament, Charles bethought him of this method of raising money. He, therefore, first demanded ships, or *money in lieu of ships*, from the maritime counties. Not content with this, he levied this tax on all the shires. It derived its name, therefore, from the purpose for which it was sought.

John Hampden refused to pay his share of the tax, for although the sum was only small, yet on it depended the question whether the King or Parliament should be supreme in the country. If the King could take what money he pleased, and in what way he pleased, then he would soon be able to do whatever else he pleased. Hence his refusal.

3. What made the English under Queen Anne take part in the War of Spanish Succession? Mention three great battles in which they were victorious, and one where they were defeated.

William III. had entered into an alliance with Austria and Holland, just before his death, against Louis XIV. and his grandson. Louis claimed for his grandson the crown of Spain. The allies supported the claims of Archduke Charles of Austria. To enforce this claim and to humble Louis, the alliance declared war against France, soon after Anne ascended the throne, A.D. 1704.

Churchill, Duke of Marlborough, defeated Louis in the battles of Blenhiem (1704), Ramilies (1706), and Oudenarde (1708). But the allies were defeated at Almanza in 1707.

Teaching.

Write notes of a lesson on lakes and their formation.

Nature of Lakes.—The natural depressions of land filled with water from rivers, springs, or rains form lakes.

Varieties of Lakes.—Lakes may be divided according to the way in which they receive, or part with their water, *e.g.* lakes which receive and give out waters; lakes which receive but do not give out waters, except by evaporation. Lakes may be also divided into salt and freshwater lakes, or into mountain lakes and lakes of the plains.

Illustrations of different kinds of Lakes.—Those which receive and give out waters are generally fed by the upper streams of a river, and are expansions of the bed of a river, *e.g.*, Lakes of the St. Lawrence in America; Victoria and Albert Nyanza, of the Nile.

Mountain Lakes belong to this class. The Swiss, Italian, and English lakes are of this class, and mountain lakes are generally noted for their great beauty and picturesqueness. Small mountain lakes are called *tarns*. The Caspian, Aral,

and Dead Seas are among those which receive, but do not give out waters. Evaporation must equal the supply. They are nearly always salt (Tchad is an exception).

Distribution of Lakes.—America has most. Africa the largest (Nyanza). Asia the highest (Sir-i-kol), and lowest (Dead Sea). Europe the most beautiful.

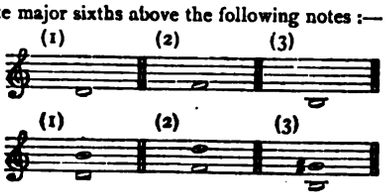
Uses of Lakes.—Regulate the discharge of rivers; expose a large surface to evaporation, and thus modify the climate, purify the rivers.

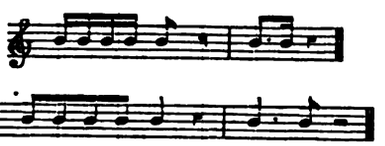
Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write major sixths above the following notes :—



2. Re-write the following, doubling the value of every note and rest :—

3. Explain (briefly) the following terms :—(1) M. 100; (2) *Dal Segno*; (3) *Staccato*.

3. (1) Metronome making 100 beats in a minute; (2) repeat from the sign 𝄋; (3) cut short, crisp.

TONIC SOL-FA NOTATION.

1. Write major sixths above the following notes :—(1) *ray*; (2) *fah*; (3) *te*,.

1. (1) *te*; (2) *ray'*; (3) *se*.

2. Re-write the following in four-pulse measure, doubling the value of each note and rest :—

1. |s ,l .s ,f :m . |s .,f :m ‖

2. |s .l :s .f |m : |s :- .f |m :— ‖

3. Explain (briefly) the following terms :—(1) M. 100; (2) *Dal Segno*; (3) *Staccato*.

3. Metronome making 100 beats in a minute; (2) repeat from the sign 𝄋; (3) cut short, crisp.

FOURTH YEAR.

Pupil Teachers at end of Fourth Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used]

(*Answer two Questions, including No. 3, if you can.*)

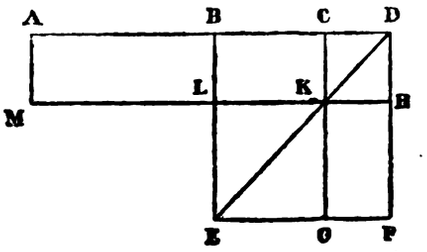
1. If a straight line be divided into two equal parts, and also into two unequal parts; the rectangle contained by the unequal parts, together with the square on the line between the points of section, is equal to the square on half the line.

Euclid : Book II., Prop. 5.

2. To divide a given straight line into two parts, so that the rectangle contained by the whole and one of the parts, shall be equal to the square on the other part.

Euclid : Book II., Prop. 11.

3. Construct a rectangle equal to the difference between two given squares.



Let AB and BC be the sides of two given squares. It is required to construct a rectangle = their difference.

Produce ABC to D and make BD = AB. On BD construct sq. BEFD. Join DE. Through C draw CKG parallel to BE or DF. Through K draw HLM parallel to AD, and through A draw AM parallel to BE. Rectangle AK = differenee between sqs. AB and BC.

BF = sq. on BD (const.) and BD = AB (const.)

∴ BF = sq. on AB. And LG = sq. on BC (II. 4.)

∴ Gnomon BHG = their difference.

∵ AB = BD, ∴ Rect. AL = rect. BH. And BK = KF (I. 43.) ∴ AK = BHG.

∴ AK = difference of sqs. AB and BC.

Q. E. F.

Algebra.

(*Answer two Questions, including No. 3, if you can.*)

1. Multiply together $\frac{a^2-x^2}{c^2-x^2}$, $\frac{bc+bx}{a^2+ax}$, $\frac{3ax}{4by}$, and $\frac{c-x}{a-x}$.

$$\frac{a^2-x^2}{c^2-x^2}\times\frac{bc+bx}{a^2+ax}\times\frac{3ax}{4by}\times\frac{c-x}{a-x}$$

Cancel 1st and 4th terms

$$=\frac{a+x}{c+x}\times\frac{bc+bx}{a^2+ax}\times\frac{3ax}{4by}$$

Cancel 1st and 2nd terms

$$=\frac{b}{a}\times\frac{3ax}{4by}$$

$$=\frac{3x}{4y}.$$ Ans.

2. Find the square root of

$$25x^4-30ax^3+49a^2x^2-24a^3x+16a^4$$

$5x^2-3ax+4a^2$. Ans.

$25x^4$

$10x^2-3ax$) $-30ax^3+49a^2x^2$

$-30ax^3+9a^2x^2$

$10x^2-6ax+4a^2$) $40a^2x^2-24a^3x+16a^4$

$40a^2x^2-24a^3x+16a^4$

3. Solve the equations:—

$$(1)\ 21y+20x=165.$$
$$77y-30x=295.$$
$$(2)\ 780x^2-73x+1=0.$$
$$(3)\ \frac{x+4}{x-4}+\frac{x-4}{x+4}=\frac{10}{3}.$$

(1) $21y+20x=165$. (I.)
$77y-30x=295$. (II.)

Mult. (I.) by 3, and (II.) by 2.

$$63y+60x=495$$
$$154y-60x=590$$
$$217y=1085$$
$$y=5.$$

Substitute value of y in (I.)

$$105+20x=165$$
$$20x=60$$
$$x=3$$

$x=3$, $y=5$. Ans.

(2) $780x^2-73x+1=0$.

$$x^2-\tfrac{73}{780}x=-\tfrac{1}{780}$$
$$x^2-\tfrac{73}{780}x+(\tfrac{73}{1560})^2=-\tfrac{1}{780}+(\tfrac{73}{1560})^2$$
$$x-\tfrac{73}{1560}=\pm\tfrac{47}{1560}$$
$$x=\tfrac{47}{1560}+\tfrac{73}{1560}=\tfrac{120}{1560}=\tfrac{1}{13}.\ \text{Ans.}$$
$$x=-\tfrac{47}{1560}+\tfrac{73}{1560}=\tfrac{26}{1560}=\tfrac{1}{60}.\ \text{Ans.}$$

(3) $\frac{x+4}{x-4}+\frac{x-4}{x+4}=\frac{10}{3}$.

$$3(x^2+8x+16)+3(x^2-8x+16)=10(x^2-16)$$
$$6x^2+96=10x^2-160$$
$$-4x^2=-256$$
$$x^2=64$$
$$x=8,\ -8.\ \text{Ans.}$$

Mensuration.

The diameter of a circle is 12 ft.: find the area of a square inscribed in it.

Diameter of circle = diagonal of sq.

Area of sq. on diagonal = area of sqs. on two sides. (Euclid, I. 47.)

∴ Area of sq. on one side, that is, the sq. in circle = ½ sq. on diag.

∴ Area of sq. $=\frac{12\times12}{2}=72$ sq. ft. Ans.

Arithmetic.

FEMALES.

1. By selling a carriage for £73 3s. 0d. I should lose 5 per cent. At what price must I sell it to gain 15 per cent.?

£73 3s. = 100 − 5 = 95.

£ s. £ s.

∴ 95 : 115 :: 73 3 : 88 11. Ans.

2. Two trains start at the same time from Sheffield and Leicester, and proceed towards each other at the rates of 30 and 50 miles per hour respectively. When they meet it is found that one train has run 14½ miles farther than the other. Find the distance between Sheffield and Leicester.

Faster train gains 20 miles in 1 hour.

∴ Time to gain 14½ miles =

mls. mls. mins. mins.

20 : 14½ :: 60 : 43½.

The distance run by the trains in 1 hour

= 50 + 30 = 80 miles.

∴ Distance run in 43½ mins. =

mins. mins. mls. mls.

60 : 43½ :: 80 : 58. Ans.

3. A, B, and C rent a field jointly for £25 12s. 5d.; A puts in 15 sheep for 6 months, B 45 sheep for 8 months, and C 81 sheep for 4 months; what should each pay towards the rent?

A 15 × 6 = 90 shares.
B 45 × 8 = 360 ,,
C 81 × 4 = 324 ,,
774

£ s. d. £ s. d.

∴ A's proportion = 774 : 90 :: 26 12 5 : 2 19 7 Ans.
B's ,, = 774 : 360 :: 26 12 5 : 11 18 4 Ans.
C's ,, = 774 : 324 :: 26 12 5 : 10 14 6 Ans.

4. What principal must have been deposited in a bank paying 4 per cent. so that at the end of 8 years the principal and interest amounted to £4785?

£

£100 would become 100 + (8 × 4) = 132.

£ £ £ £

∴ 132 : 4785 :: 100 : 3625. Ans.

Grammar.

MALES AND FEMALES.

1. I would the great world grew like thee
Who grewest not alone in power
And knowledge; but from hour to hour
In reverence and in charity.

—TENNYSON.

Analyse this stanza; and explain, if you can, its metre.

ANALYSIS.

Sentence.	Kind of Sent.	Connective.	Subject.	Predicate.	Object.	Extension.
(*a*) I would	Prin. S.		I	would		
(*b*) the great world grew like thee	Noun. S. Obj. to (*a*)	*that* und.	the great world	grew		like thee
(*c*) who grewest not alone in power and knowledge	Adj. S. to *thee* in (*b*)	*In rel.*	who	grewest	in power and knowledge (ind.)	not only
(*d*) but from hour to hour in reverence and in charity	Adj. S. to *thee* in (*b*)	but	[who]	[grewest]	in reverence and in charity (ind.)	from hour to hour

The stanza is a tetrameter of four lines, the measure of which is Iambic, that is, having an unaccented and accented syllable in each foot. The rhyming lines are the first and fourth, and the second and third.

2. Give the etymology and exact meaning of as many of the following words as you can:—

Fortress, Fortitude, Subscribe, Superior, Domination, Rectitude, Impossible, Construction, Export.

Fortress—derived from Latin *fortis*, strong, through the French *forteresse*; a strong, fortified place.

Fortitude—from the Lat. *fortitudo*, strength; originally it meant strength, now it refers to strength of mind to bear ills.

Subscribe—from Lat. *sub*, under, and *scribo*, I write; to write underneath; to sign one's name; to promise to give money by writing underneath.

Superior—a Latin comparative from *super*; higher in rank, position, or quality.

Domination—from Lat. *dominatus*, mastery; lordship, mastery, government, sometimes tyranny.

Rectitude—from Lat. *rectitudo*, right; correctness of conduct or principle; uprightness.

Impossible—from Lat. *im*, not, and *possibilis*. possible (*possum*, to be able); not possible, that which cannot be accomplished.

Construction—from Lat. *con*, together, and *struo*, I build; that which is constructed or built together.

Export—from Lat. *ex*, out, and *porto*, I carry; that which is carried out, or sent from one country to another.

3. Give an example of an 'Infinitive of purpose;' and also of an Infinitive used as equivalent to a noun.

Infinitive of purpose:—

I come to bury Cæsar.

Infinitive used as a noun:—

To err is human; to forgive, divine.

4. Say what you know about the life or writings of Milton, Pope, and Dr. Johnson.

Milton was a prominent supporter of the Parliament in the time of Charles the First. He wrote many political pamphlets in favour of that body, and became Latin Secretary to Cromwell. His greatest work was a descriptive poem on the Fall, entitled 'Paradise Lost.' It was written after the Restoration, when Milton was in poverty and afflicted with blindness. He wrote also 'Paradise Regained,' 'Comus,' a play, 'Samson Agonistes,' 'L'Allegro,' and 'Il Penseroso.'

Alexander Pope's chief works are, 'The Rape of the Lock,' a short poem in imitation of the actions of the Greek heroes; and a translation of the 'Iliad' of Homer, still extensively read and admired for the ease and elegance of its verse. He is considered one of the most finished of English poets.

Dr. Samuel Johnson was born at Lichfield. He died in 1784. He is chiefly known through the biography of Boswell. He compiled an 'English Dictionary,' wrote 'Rasselas,' an Eastern Tale; 'The Lives of the Poets,' a poem called 'London,' and conducted several magazines.

Geography.

1. State some of the chief physical differences between the New World, North and South America; and the Old World, Europe, Asia, and Africa.

The axis of greatest length in the New World is from north to south, in the Old World from east to west. The mountain ranges in the N.W. are near the coast, in the O.W. nearer the centre. The rivers in the N.W. nearly all flow in an easterly direction, and are of great length, those on the west slope of the great mountain chain being short and rapid. In the O.W. they flow from all slopes, and are more uniform in length. There is a much greater proportion of land in the Torrid Zone in the O.W. than in the N.W.

The coast of the Old World is generally much more indented than that of the N.W. Great fresh-water lakes are a marked feature of the N.W., while those of the O.W. are comparatively few, and of these many are salt. The general level of the O.W. is higher than that of the N.W., especially in Asia.

2. Explain as to a class the nature and causes of tides.

Bodies attract each other, according to their size and distance apart. The sun, moon, and earth thus have an influence over each other. The water of the earth being free to move, is most susceptible to this influence. The moon being much nearer to the earth than the sun, although a small body, attracts the waters of the earth more than the sun. The waters, therefore, accumulate on the side of the earth nearest the moon. The solid earth is also attracted, but the force exerted being felt at a greater distance, and the earth moving as one mass, the movement towards the moon is not so great as the water. The waters on the opposite side of the earth being most remote, are not so much acted on, and as the earth is drawn from them, there is an accumulation on that side also. As the moon travels daily round the earth, the heap of waters follows also, and there are thus two times of high water at every part of the coast every day. And as the waters are drawn away from that part of the coast which is at right angles to the moon's influence, there is low water at every place also twice a day.

The sun's influence is sometimes added to that of the moon. At other times it acts against it. (Show by diagrams.)

3. What four planets are nearest to the sun? Describe one of them.

The four primary planets nearest the sun are Mercury, Venus, Earth, and Mars, although Vulcan and Pluto are said to have orbits inside of Mercury.

Of these Venus presents a much more brilliant appearance than any other, and is known to us as the morning and evening star. As its orbit is within that of the earth, it can never appear at a greater angular distance from the sun than about 45°; it will also be seen in various phases, and will sometimes make a transit across the sun's disc. Its diameter is about 7500 miles, and its yearly revolution takes place in 235 days. It rotates on its axis in 23¼ hours. It is sometimes so brilliant that it can be seen even during daylight.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. If a grocer buys sugar at 30s. per cwt., and sells it at 3½d. per lb., what per cent. does he gain?

	s.	d.
Selling price = $3\frac{1}{2} \times 112$ =	32	8
Cost price =	30	0
Gain =	2	8

30 : 100 :: 2⅔ : 8⅔. Ans.

2. What sum of money, lent at 5 per cent. per annum compound interest, will amount in 2½ years to £904 1s.?

Compound interest on £100.

		£	s.	d.	
$5 = \frac{1}{20}$		100	0	0	
		5	0	0	
$5 = \frac{1}{20}$		105	0	0	End of 1st yr.
		5	5	0	
For ½ yr. $5 = \frac{1}{40}$		110	5	0	End of 2nd yr.
		2	15	1½	
		£113	0	1½	End of 2 yrs. and 6 mos.

£ s. d. £ s. £ £

113 0 1½ : 904 1 :: 100 : 800. Ans.

3. A lends £1815 at 4 per cent. interest, and B invests the same amount in 4½ per cent. debentures at 110; after a year B sells out at 111½. How much has B made more than A? (Omit brokerage.)

A receives as interest $\frac{1815 \times 4}{100} = £72\ 12s.$

∴ At the end of the year he has £1815 + £72 12s. = £1887 12s.

B receives as interest $\frac{1815 \times 4\frac{1}{2}}{110} = £74\ 5s.$

He sells out for $\frac{1815 \times 111\frac{1}{2}}{110} = £1839\ 15s.$

∴ He has at the end of the year £1839 15s. + £74 5s. = £1914.

B has more than *A*, £1914 − £1887 12s.

= £26 8s. Ans.

4. A owes B £2926, payable 12 months hence. If A pays B 4 months hence, how much ought he to pay in exact discharge of the bill, interest being reckoned at 4 per cent. per annum?

A pays *B* eight months before bill is due.

£100 in 8 months at 4 per cent becomes (100 + ⅓ of 4)

= 102⅔

∴ Present worth of £2926 for 8 mos. =

£ £ £ £

102⅔ : 100 :: 2926 : 2850. Ans.

History.

MALES AND FEMALES.

1. When and how did the Colonial Empire of England begin? Give some general description of its extent at the present time.

After the discovery of America by Columbus, permission was given to John Cabot and his son to search for islands, countries, and regions before unseen, and take possession of them as vassals of the English Crown. They discovered Newfoundland and Labrador, reaching the country before Columbus. In Elizabeth's reign, however, the actual colonization began. Virginia was the first settlement made (1584). Other colonies were afterwards founded by those who left the country, either from persecution or war. The growth of the number and extent of the colonies has been greatest in modern times.

England now possesses nearly the whole of India, all Ceylon, Australia, New Zealand, 3½ million square miles in North America, half a million square miles in South Africa, besides

islands in the West Indies and the Pacific, settlements on the West Coast of Africa, on the east side of the Bay of Bengal, and in other places.

The British Empire is the largest in the world, except Russia, and the most populous, except China.

2. How did our forefathers look upon barracks and a standing army? How do you explain the change in popular feeling on this subject?

The foundation of a standing army and barracks was looked upon by the people of this country with a feeling of distrust, and met with considerable opposition. They saw in the one only a means of interference and meddling abroad and an increase of the power of the king, and in the other a means of oppression and taxation at home.

The change has come about since the growth of the power of Parliament, the limitation of the power of the king, the extension of our colonial empire, the increase of population and manufactures, and the spread of education and popular power by the extension of the franchise to almost all classes of people.

3. When did the House of Hanover come to the throne? Show the names and relationship of all our sovereigns of that House, with their dates.

The Act of Settlement passed after the accession of William III. provided that the crown should pass to his children if he left any, then to Anne or her heirs, and in default of either to the descendants of Elizabeth, daughter of James I. Elizabeth married the Elector Palatine, and had issue Sophia, who married Ernest Augustus, the Elector of Hanover. On the death of Queen Anne, George, the son of the Electress Sophia, became King of England.

The sovereigns of the House of Hanover are:—

	A.D.	A.D.
George I., great grandson of James I. ...	1714—	1727
George II., son of George I.	1727—	1760
George III., son of Frederick, Prince of Wales, and grandson of George II.	1760—	1820
George IV., son of George III.	1820—	1830
William IV., brother of George IV. ...	1830—	1837
Victoria, daughter of the Duke of Kent, and niece of William IV.	1837	

4. Who sit in the House of Peers? Explain the name, and discuss the constitutional advantages of a Second Chamber.

The House of Peers consists of the Lords Spiritual and Temporal of England, and the Representative Peers of Ireland and Scotland. Twenty-six Bishops of the Church of England occupy their seats for life, or till the resignation of their bishopric. The Lords Temporal are of five orders, Dukes, Marquises, Earls, Viscounts, and Barons. Their title is hereditary. The repre sentative peers of Ireland are elected for life, the Scottish peers for a single Parliament only.

The word means *an equal*, and is derived from the Latin *par*, equal, and the persons sitting in the House of Lords sit there as equals.

Perhaps the chief advantages of a Second Chamber are, that it provides for the reconsideration of measures which may have been hurriedly passed, or only imperfectly and partially considered by a body of men who are not subject to the capricious changes of opinion which often occur among a numerous and partially-educated population.

Teaching.

Write notes of a lesson on one of these subjects:—

The four seasons.
Gold.

Cause of Seasons.—The inclination of the earth's axis to the plane of its orbit. *Illustration.* Place lamp on table, and move globe round it with axis perpendicular. From this derive, that half of the earth receives light and heat at once; that if the earth's axis were perpendicular there would never be any change of season, each place on the earth would have always 12 hours day and 12 hours night.

Inclination of Axis, and its Effects.—23½ degrees. Now show the effects of inclining the axis, and keeping the inclination always parallel to itself. Place the globe with north pole turned towards lamp. Make it revolve, and show that parts round about the North Pole never lose sight of the sun during the revolution; then draw attention to the South Pole, and elicit that the people there never see the sun during that revolution.

Changes places, and observe change of season. These give winter and summer clearly.

Next move globe slowly, till it occupies place midway between former positions. Show that North Pole and South Pole are then equally distant from sun, and that each place will have twelve hours day and night in the revolution.

From this derive, that the North Pole and the district 23½ degrees around it passes from all day gradually to all night during the revolution, that the amount of heat received varies according to length of day; that this variation we name the seasons.

The Seasons.—Spring, Summer, Autumn, Winter. Name the months for each in this country, and show that the further a place is from the North or South Pole the less difference there is in the seasons.

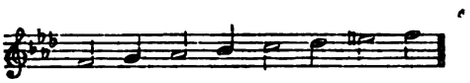
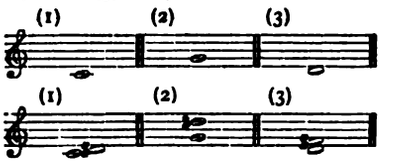
Benefits of the Seasons.—Nearly all parts of the earth are rendered habitable; greater variety of climate; greater diversity of products; temperate zones produce fruits which would never ripen but for this change.

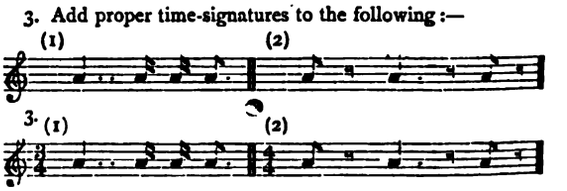
Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write in the Treble clef the signature and the ascending scale of F minor, using the minor or flat sixth and the major or sharp seventh.

1.

2. Write above (1) an augmented second; above (2) an augmented fifth; above (3) a major third:—

3. Add proper time-signatures to the following:—



TONIC SOL-FA NOTATION.

1. Write (1) above *doh* an augmented second; (2) above *soh* an augmented fifth; (3) above *ray* a major third.

1. (1) *Ra*; (2) *re*^{1}; (3) *fe*.

2. In the minor or *lah* mode (1) which is the essential or minor sixth and (2) which is the essential or major seventh?

2. (1) *Fah*; (2) *se*.

3. Write the following in six-pulse measure by trebling the value of every note:—

| s ,m ,l :s ,d ,- | m ,- ,r :d ‖

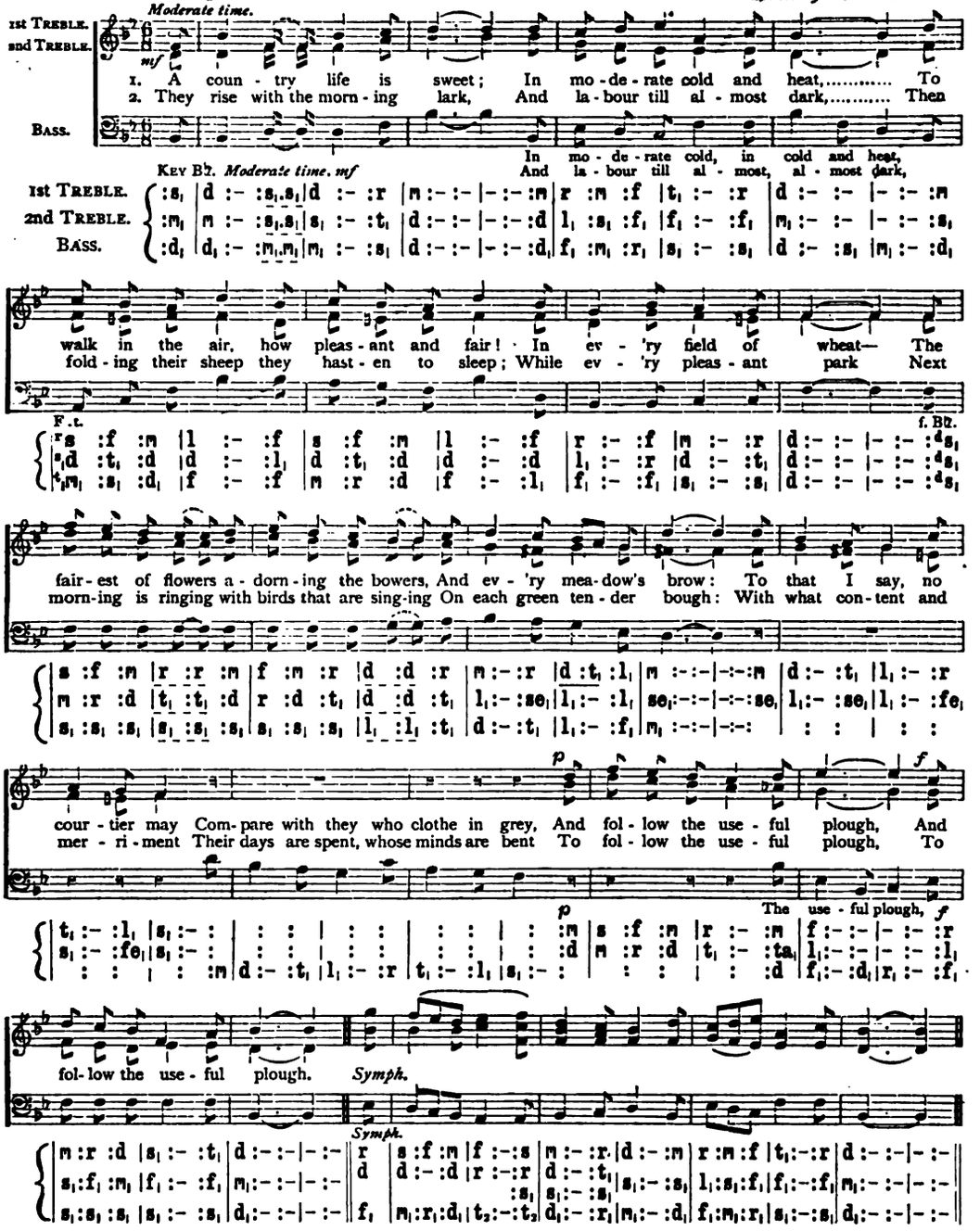
3.

| s :m :l | s :d :— | m :— :r | d :— :— ‖

THE USEFUL PLOUGH.

*Words from an Old English Ballad.**

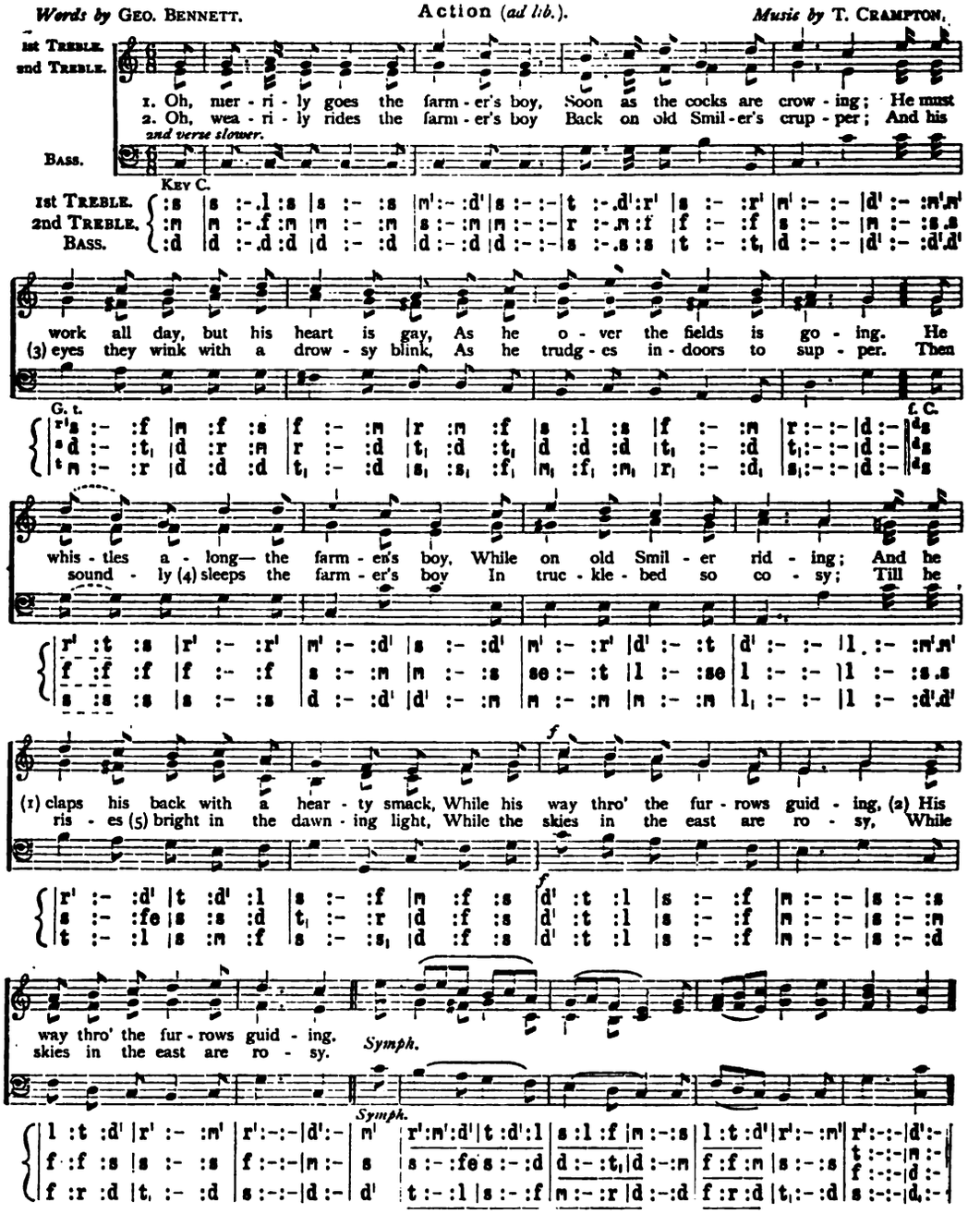
Music by T. CRAMPTON.


Moderate time.
1st Treble.
2nd Treble.
Bass.
mf
1. A coun - try life is sweet; In mo - de - rate cold and heat,..... To
2. They rise with the morn - ing lark, And la - bour till al - most dark,..... Then
In mo - de - rate cold, in cold and heat,
And la - bour till al - most, al - most dark,
Key B♭. Moderate time. mf
walk in the air, how pleas - ant and fair! In ev - 'ry field of wheat— The
fold - ing their sheep they hast - en to sleep; While ev - 'ry pleas - ant park Next
F.t.
f. B♭.
fair - est of flowers a - dorn - ing the bowers, And ev - 'ry mea - dow's brow: To that I say, no
morn - ing is ringing with birds that are sing - ing On each green ten - der bough: With what con - tent and
p
f
cour - tier may Com - pare with they who clothe in grey, And fol - low the use - ful plough, And
mer - ri - ment Their days are spent, whose minds are bent To fol - low the use - ful plough, To
p
The use - ful plough, f
fol - low the use - ful plough.
Symph.
Symph.

* The older copies of this Ballad have the words "Painful Plow."

THE FARMER'S BOY.

Words by GEO. BENNETT. Action (*ad lib.*). *Music by* T. CRAMPTON.


1st TREBLE.
2nd TREBLE.
BASS.
1. Oh, mer - ri - ly goes the farm - er's boy, Soon as the cocks are crow - ing; He must
2. Oh, wea - ri - ly rides the farm - er's boy Back on old Smil - er's crup - per; And his
and verse slower.
KEY C.
work all day, but his heart is gay, As he o - ver the fields is go - ing. He
(3) eyes they wink with a drow - sy blink, As he trudg - es in - doors to sup - per. Then
whis - tles a - long— the farm - er's boy, While on old Smil - er rid - ing; And he
sound - ly (4) sleeps the farm - er's boy In truc - kle - bed so co - sy; Till he
(1) claps his back with a hear - ty smack, While his way thro' the fur - rows guid - ing, (2) His
ris - es (5) bright in the dawn - ing light, While the skies in the east are ro - sy, While
way thro' the fur - rows guid - ing.
skies in the east are ro - sy.
Symph.

(1) Slap right hand on the leg. (2) Point straight ahead. (3) Blink the eyes, as if sleepy. (4) Close eyes, and imitate being asleep. (5) All suddenly jump up, and finish the song standing.

Chemistry of the Non-Metallics.

BY EDWARD AVELING, D.SC. LONDON.

[This series of articles, whilst dealing with the subjects required by the University of London for the Matriculation Examination and with those required at the Elementary Stage of the Inorganic Chemistry (Branch X.) Science and Art Department, is intended as a practical guide to the philosophical and systematic study of the non-metallics.]

CHAPTER IV.—HYDROGEN—(*continued*).

PROPERTIES. DIFFUSION OF GASES.

D. *The Properties of Hydrogen.*—If the student has carefully observed the behaviour of the gas prepared in any one of the four experiments given above he will be able to make out its properties.

(1) *Condition.*—A gas at ordinary temperatures. Until recently all efforts to liquefy hydrogen had failed. The two chief agents in liquefying gases are reduction of temperature and increase of pressure. Each of these helps to bring the particles of the gas closer to each other. Cohesion between these particles triumphs over the repulsion of them one by the other, and a liquid results. A pressure of 3,000 atmospheres, *i.e.*, 3,000 times as great as the pressure of the air at the earth's surface, or 3,000 times 1,033 grams on the square centimetre has been applied to hydrogen without liquefying it. Hence hydrogen was for a long time spoken of as a permanent gas, *i.e.*, one that could not be reduced to the liquid state. In 1878-9, however, two Frenchmen, MM. Cailletet and Pictet, working quite independently one of the other, succeeded by the use of very ingenious methods in liquefying hydrogen and all the other gases said to be permanent.

The method employed by M. Pictet is as follows. The tube of glass containing the gas to be liquefied (5 metres long, 14 mm. in external diameter, 4 in internal, and therefore 5 mm. in thickness) is placed in a tube containing solid carbon dioxide. The latter is frozen by being placed in a tube containing liquid sulphur dioxide. The vapour of this last is constantly drawn off from the surface of the liquid by means of a vacuum-pump. The evaporating sulphur dioxide, producing a temperature of $-65°$ to $-70°$, cools the carbon dioxide. The solid carbon dioxide has a temperature of $-140°$. The gas within the innermost tube is, at the same time as it is cooled by the frozen carbon dioxide, subjected to great pressure (500 atmospheres, *e.g.*). On turning a stop-cock at the free projecting end of the tube containing the gas to be liquefied, the latter escapes as a liquid.

The method employed by M. Cailletet is as follows. The gas to be liquefied is placed in a small tube of glass, surrounded by a freezing mixture, and so arranged that the gas may at a certain moment be put into connection with the air. This glass tube opens below into a cylinder of steel, containing mercury. This mercury, pressed on by water that is forced into the cylinder from a massive steel cylinder, presses on the gas. When the latter, lowered in temperature by the freezing mixture and compressed by the mercury that is under pressure from the forced-in water, is suddenly allowed to escape into the air its expansion causes a very great reduction of temperature and the gas is liquefied.

(2) *Effect on the Senses.*—Without taste or odour; invisible and colourless.

(3) *Specific Gravity.*—The lightest terrestrial body known. It is indeed the standard of comparison for all gases as to weight. The specific gravity of a body is its weight in reference to the weight of an equal volume of some standard body. Its density is the amount of matter, or the mass, of a certain volume of any substance, as compared with the mass of an equal volume of the standard. The student is warned not to confuse specific gravity with density, or weight with mass. A body may have no weight. It must have mass. As hydrogen is the lightest substance known, it is taken as the standard for gases. Its specific gravity and its density alike are represented by the number 1. The air is sometimes taken as the standard for gases. There are two reasons why it is not a good standard. It is a mixture, not an element, and it is, compared with hydrogen, a heavy gas. Air is 14·47 times as heavy as hydrogen. Hence the specific gravity of any gas can be expressed upon the air-scale by dividing its specific gravity upon the hydrogen scale by 14·47. The specific gravity of hydrogen on the air-scale is $1 \div 14{\cdot}47 = {\cdot}069$.

By the law explained on page 259, 11·2 litres of hydrogen at 0° and 760 mm. weigh 1 gram, therefore 1 litre weighs $\frac{1}{11{\cdot}2}$ grams = ·0896 grams. This number ·0896, much used in chemical arithmetic, is called the crith, κριθη (crithē) = a barleycorn. The weight of a litre of any other gas may be calculated by multiplying the crith by the number representing specific gravity of the gas.

(4) *Solubility.*—Very little soluble in water. 100 cc. of water at normal temperature and pressure dissolve 1·93 cc. of hydrogen.

(5) *Relation to Combustion.*—Inflammable, but not a supporter of combustion. If a lighted taper is plunged into the gas, the taper goes out, and the hydrogen burns, uniting with the oxygen of the air to form hydrogen oxide, or steam. Hydrogen and oxygen mixed together burn on application of a light with explosive violence. If mixed in the proportion of 2 and 1, their combining proportions by volume, the explosion is dangerously violent.

Symbols of the combustion of hydrogen:

$$2H^2 + O^2 = 2H^2O$$
$$4 + 32 = 36$$
4 vols. 2 vols. 4 vols.

It will be seen that the two gases unite in the proportion of 4 and 32 by weight to form 36 by weight of water, or (dividing by 4) in the proportion of 1 to 8 to form 9 by weight of water.

The volume-relationship demands close attention. 4 vols. of hydrogen with 2 of oxygen only form 4 vols. of steam. To understand this we must turn to the law explained on page 259, and see how the weights and volumes of compound gases are related.

1 gram hydrogen at 0°C. and under 760 mm.	}	occupy each 11·2 litres.
16 grams oxygen ,, ,, ,, ,,		
14 ,, nitrogen ,, ,, ,, ,,		

And, generally, the number of grams of any *element* gas represented by the weight-number of the element occupy at normal temperature and under normal pressure 11·2 litres.

The weight-number of the compound gas, steam (H^2O) = 18.

18 grams steam (H^2O) at normal temperature and pressure occupy 22·4 litres, and generally the number of grams of any *compound* gas represented by the weight-number of the compound, occupy at normal temperature and under normal pressure 22·4 litres or 2 volumes.

In the special case under consideration, therefore, the 4 vols. of hydrogen and the 2 vols. of oxygen are condensed into 4 vols. of steam.

EXERCISES ON THE BURNING OF HYDROGEN (*solved*).

39. 20 grams hydrogen are burnt. What weight of oxygen is required and what weight of steam is formed?

4 grams H require 32 O and form with them $36H^2O$
1 gram ,, requires $\frac{32}{4}$ O and forms ,, $\frac{36}{4}$,,
20 grams ,, require $\frac{32 \times 20}{4}$ O and form ,, $\frac{36 \times 20}{4}$,,
= 160 grams O, 180 grams H^2O.

40. 22·4 litres steam are required. What weight of hydrogen, and what volume of oxygen are needed?

4 vols. = 44·8 litres H^2O need 4 grams H and 22·4 litres O
1 litre ,, needs $\frac{4}{44{\cdot}8}$,, ,, $\frac{22{\cdot}4}{44{\cdot}8}$,,
22·4 ,, ,, need $\frac{4 \times 22{\cdot}4}{44{\cdot}8}$,, $\frac{22{\cdot}4 \times 22{\cdot}4}{44{\cdot}8}$
= 2 grams H, 11·2 litres O.

41. How many cc. of oxygen must be mixed with 1 gram of hydrogen that upon explosion nothing but steam may be left?
4 grams H require 2 vols. = 22·4 litres = 22400cc. O
1 gram „ requires $\frac{22400}{4} = 5600$ cc. O.

42. A mixture of equal volumes of oxygen and hydrogen is exploded. What gas will be left after the explosion, and what proportion of the original mixture will it equal?
4 vols. H need 2 vols. O
1 vol. „ needs $\frac{1}{2}$ vol. „ $= \frac{1}{2}$
Hence all the H will be used and $\frac{1}{2}$ the O,
$\therefore \frac{1}{2}$ of $\frac{1}{2}$, or $\frac{1}{4}$ of the original mixture will be left.

43. 75cc. oxygen and 25cc. hydrogen are exploded. Supposing that no condensation takes place, what vol. of steam is formed, and what volume of which of the two gases is left?
4 vols. H with 2 vols. O = 4 vols. H^2O
1 vol. „ „ $\frac{1}{2}$ vol. „ = 1 vol. „
25 vols. „ „ $\frac{25}{2}$ vols. „ = 25 vols. „
$\therefore 75 - \frac{25}{2} = 62\frac{1}{2}$cc. O and 25cc. H^2O are left.

EXAMPLES ON THE BURNING OF HYDROGEN (*for solution*).

33. How much oxygen by weight and by volume is necessary for the combustion of $\frac{1}{2}$ gram of hydrogen?...4 grams, 2·8 litres.

34. 224 grams water are required. What weight hydrogen and oxygen must be taken?.....$24\frac{8}{9}$ and $199\frac{1}{9}$.

35. What weight of hydrogen must be mixed with 1 gram of oxygen, that upon explosion nothing but steam may be left? ... $\frac{1}{8}$ gram.

36. A mixture of equal weights of oxygen and hydrogen is exploded. What gas will be left after the explosion, and what proportion by weight of the original mixture will it equal?.. ... Oxygen; $\frac{7}{8}$.

37. 12cc. of hydrogen and 15cc. of oxygen are exploded. What gases are left after the explosion, supposing that no condensation takes place?.....12cc. steam, 9cc. oxygen.

38. What volume of hydrogen must be mixed with 8 grams oxygen that after the explosion 500cc. of hydrogen may be left? 11700cc.

(6) *Specialties.*—Hydrogen by its extreme tenuity renders sounds very weak. A bell rung in a jar of hydrogen can scarcely be heard. Hydrogen is a great reducing agent, *i.e.*, it readily takes away oxygen from compounds containing that element, and uniting with it forms water If the gas is driven over the magnetic iron oxide formed in the experiment described on page 378, water is formed and iron is left.

Symbols	$Fe_3O_4 + 4H^2$	=	$4H^2O$	$+ 3Fe.$
Weight numbers and volumes	$56\times3+16\times4+8$	=	$4(2+16)$	$+ 3\times56$
	232		72	168
	8 vols.			

QUESTION ON THE REDUCING ACTION OF HYDROGEN (*solved*).

43*a*. How much iron will remain as a free metal after 11·2 litres hydrogen have been passed over heated iron rust?
If $8\times11{\cdot}2$ litres H. are used, 168 grams Fe remain.
$1\times11{\cdot}2$ „ „ „ $\frac{168}{8}$ „ „ = 21 grams.

QUESTION ON THE REDUCING ACTION OF HYDROGEN (*for solution*).

(38*a*.) Find weight of water that may be formed by the reducing action of 7 grams hydrogen .....63 grams.

One other specialty of hydrogen is its power of decomposing certain salts when it is just liberated from a compound that contains it, *i.e.*, when it is in a *nascent* condition (nascor = I am born). Pass hydrogen gas into a solution of ferric chloride (Fe_2Cl_6), and no change occurs. But place in a solution of ferric chloride (which is of a yellowish colour) some zinc and sulphuric acid, and the nascent hydrogen decomposes the salt and discharges the colour.

The rapidity of its diffusion is another special point. Diffusion is the passage of one gas into the space occupied by another. Take some plaster of Paris, mix it with water, spread the mixture on filter paper. Take a glass tube $\frac{1}{4}$ of an inch in diameter, and some two or three feet long. Press one end of the tube into the moistened plaster of Paris, and let the plaster set. The tube will be closed at one end by a porous plug of plaster of Paris. Fill the tube with hydrogen, and place its open end in a vessel

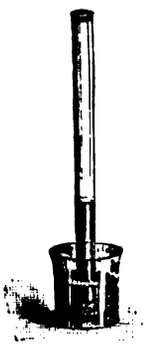


Fig. 14.

containing any coloured liquid. (Fig. 14.) The liquid is seen to rise within the tube. The hydrogen is diffusing out through the plug more rapidly than air is passing in through the plug.

Another method of showing the diffusion of hydrogen is to join the tube with its porous plug to a U-shaped tube containing water, and to place over the plug-end a beaker (B, Fig. 15.) Pass hydrogen into this beaker, and

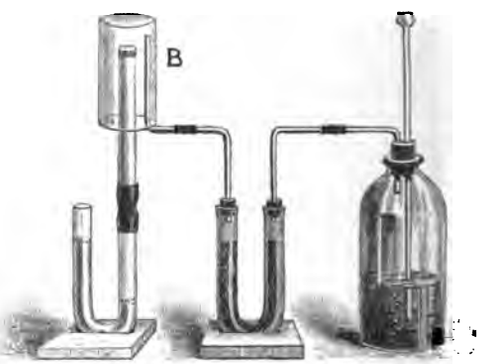


Fig. 15.

the hydrogen in the beaker B will pass through the porous plaster more quickly than the air passes out, and will force the water below up and out of the free limb of the bent tube.

It is found that the lighter a gas is, the more rapidly it diffuses. Experiments with various gases show that the power of diffusion of gases varies inversely as the square roots of their densities. Oxygen is 16 times as heavy as hydrogen. The square root of 16 is 4, of 1 is 1. Hydrogen diffuses 4 times as rapidly as oxygen.

EXERCISES ON THE DIFFUSION OF GASES (*solved*).

(44.) If in a certain time 200 cc. oxygen pass through a porous plug, what volume of hydrogen, and what volume of nitrogen will pass through in the same time under similar conditions?

Densities of oxygen, hydrogen, and nitrogen are 16, 1, 14.
Square roots of densities „ „ „ 4, 1, $\sqrt{14}$.
Of gas with density whose sq. root is 4, 200 cc. diffuse.
„ „ „ 1, $200\times4 = 800$ cc. „
$\sqrt{14}$ $\frac{200\times4}{\sqrt{14}} = \frac{800}{3{\cdot}74}$ „ „
$= 213{\cdot}9$ cc.

(45.) Compare the densities of two gases when one litre of the one and 6,400 cc. of the other diffuse out of the same tube under the same circumstances.

Vols. diffused = 1,000 cc. and 6,400.

$$\frac{\sqrt{(\text{density of the first})}}{\sqrt{(\text{density of the second})}} = \frac{1000}{6400} = \frac{5}{32}$$

$$\therefore \frac{\text{density of the first}}{\text{,, ,, second}} = \frac{32^2}{5^2} = \underline{\frac{1024}{25}}.$$

EXAMPLES ON THE DIFFUSION OF GASES (*for solution*).

(39.) Compare the diffusion volumes of air and hydrogen. 3·803 : 1.

(40.) How much chlorine gas will diffuse while a litre of oxygen diffuses?.....671·1 cc.

(41.) What is the density of a gas 300 cc. of which diffuse in the same time as 1800 cc. of hydrogen?.....36.

(*To be continued.*)

Physiology.

BY ARTHUR NEWSHOLME, M.D. LOND.,

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CHAPTER XI.—THE CIRCULATION OF THE BLOOD—(*continued*).

The Mechanism of the Circulation.—The chief agents concerned in it are the following:—

1. The rhythmical action of the heart.
2. The elasticity and muscular contractility of the arteries.
3. The elasticity of the capillaries, and the relation between them and their surrounding tissues.
4. The valves of the veins, preventing reflux.
5. The effect of the contraction of voluntary muscles on the veins.
6. Inspiration favours the venous circulation, and expiration the arterial.

The Heart is the central organ of circulation. The course of the circulation through it has been already described. It must be distinctly remembered that the two sides are contracting synchronously, the heart being really a double organ, by which the blood is propelled in two different directions. The contraction of the auricles of the heart sends the blood into the corresponding ventricles, which were previously empty. This contraction might possibly drive the blood back into the large veins near the heart, as they are destitute of valves; but this is prevented by the fact that the veins are already full of blood flowing towards the heart, while the ventricles are empty, and consequently the blood flows in the direction of least pressure.

As soon as the blood comes in contact with the interior of the ventricular walls, it excites their contraction. This contraction completely empties them, forcing the blood into the aorta and pulmonary artery, which arise from the left and right ventricle respectively. But as these arteries are already full of blood, the ventricular contraction requires a longer time and greater force than the auricular. Why does no blood flow back into the auricular cavities? This is owing to the perfect adaptation of the mitral and tricuspid valves at the moment of ventricular contraction. The return of blood from the aorta and pulmonary artery is prevented by the closure of the semilunar valves, and the blood is consequently forced onwards by the elastic recoil of the arteries to the peripheral parts of the body.

The time during which an auricle or ventricle is contracting is called its *systole*; the *diastole* being the passive period of refilling. Thus there are four periods in the cycle of events: auricular diastole, auricular systole, ventricular diastole, and ventricular systole. Inasmuch, however, as the ventricular systole occurs at the same time as the auricle is being refilled, and the ventricular diastole at the same time as the auricular contraction, these periods may be reduced to two.

If we suppose a cardiac revolution, including these four events, to occupy $1\frac{1}{10} = \frac{11}{10}$ sec., the following will be the relative duration of each event:—Contraction of auricles, $\frac{1}{10}$ sec.; of ventricles, $\frac{4}{10}$ sec.; period of repose (no contraction of either auricle or ventricle), $\frac{6}{10}$ sec.

Sounds of the Heart.—When the ear is placed over the region of the heart, two sounds are heard, following each other in close succession, and succeeded by a short pause, and then a repetition of the same sounds.

The first sound is dull and booming. It corresponds in time to the visible impulse of the heart, which can be seen between the fourth and fifth left ribs, a little lower than the left nipple, and between it and the sternum. This impulse is owing to the tilting up of the heart at the moment of ventricular contraction. If one finger be placed on the chest at the point of cardiac impulse, and another on the radial pulse (at the wrist) of any individual, the impulse (as well as the first sound) will be found to momentarily precede the radial pulse.

The second sound is shorter and sharper than the first, and follows close after the radial pulse. The difference between the two sounds may be expressed by saying the words *lubb-dup*.

During 1st sound.	*During 2nd sound.*
Contraction of ventricles.	Commencement of dilatation of ventricles.
Commencement of dilatation of auricles.	Dilatation of auricles.
Closure of auriculo-ventricular valves.	Opening of auriculo-ventricular valves.
Opening of aortic and pulmonary valves.	Closure of aortic and pulmonary valves.
Impulse occurs.	

The cause of the second sound is the sudden closure and vibration of the semilunar valves on the two sides of the heart. Usually, the two sides produce one sound, but occasionally there is a lack of synchronism, and then a reduplication of the second sound occurs.

That this is the true explanation is abundantly proved by disease. When, owing to thickening or puckering of the valves, they do not properly approximate, the sound is replaced by a *bruit* or murmur.

The cause of the first sound is less certain. It is not due to the impulse of the heart's apex against the chest wall, as it occurs when the latter is removed. The two other explanations given are that it is due (1) to vibration of the auriculo-ventricular valves, or (2) that it is a muscular sound. The muscular view of its origin seems to be negatived by the fact that muscular sounds are only produced by tetanic contractions, while the cardiac contraction is a single spasm; and the valvular origin of it is strongly confirmed by the fact that it becomes much obscured

when the valves are diseased. Both views, however, present difficulties, and these are not removed by supposing that it is both a muscular and valvular sound.

The *work done by the heart* at each contraction is very considerable. Calculations are not altogether reliable; but the mean of various results, is that about six fluid ounces of blood are ejected by each ventricle during its systole by an average adult. It is evident that each ventricle must eject exactly the same amount, as, otherwise, the whole of the blood would eventually accumulate either in the systemic or pulmonary circulation. The pressure of the blood in the right ventricle is much less than that in the left (30 to 40 millimètres of mercury as compared with 200 mm.), but, owing to the smaller amount of peripheral resistance in the lungs, this is quite sufficient to drive out an equal quantity of blood.

It is probable that the amount of blood leaving the ventricles varies considerably at different times. Supposing six ounces leave the ventricles with each stroke, and that the weight of the blood is one-thirteenth part of the weight of the body, the whole of the blood will pass through the heart in thirty-two beats—*i.e.*, in about half a minute.

The *frequency of the heart's beat* varies greatly. In the adult its frequency averages seventy beats per minute. It is quicker in children than adults; in females than males, and in short persons than in tall. It is increased by exertion, and is quicker standing than sitting, and sitting than lying. It is quickened by increased rarity of the atmosphere, and most markedly affected by mental conditions.

Nervous Relations of the Heart.—All the phenomena hitherto considered are purely physical, and can be imitated by mechanical contrivances outside the body. An apparatus can be invented, driving a given amount of fluid from a central source into a complicated system of tubes. But such a system would lead, in the animal economy, not to nutrition but destruction. The brain and stomach, for instance, would receive their dole of blood with a fatal regularity whether they were working or resting. We must now turn our attention to the vital mechanisms which enable the supply of blood to be exactly adapted to circumstances.

The contraction of the heart is not under the control of the will; it is automatic, and the impulses causing it arise in the heart itself. This can be proved in the case of cold-blooded animals, like the frog or turtle, in which the heart continues to beat for considerable periods after its removal from the body, even after the cavities have been cleared of blood. If the ventricle of a frog's heart be divided from the auricle, both continue to beat. If the auricle be divided longitudinally, each half will go on beating spontaneously; and the division may even be carried further, with similar results. If the ventricle be divided longitudinally, each portion continues to pulsate; but if divided transversely, the lower half remains motionless, while the upper half pulsates. It is found that the parts possessing the power of spontaneous pulsation possess ganglia (composed of nerve cells, and fibres), while these are absent from the ventricles, except at the extreme base. It would appear, therefore, that the pulsations of the heart are associated with, and probably due to, the presence of these nerve ganglia in its substance.

The beat of the heart may be stopped, or, in other words, *inhibited*, by impulses sent along the vagus, or pneumogastric nerve. The effect varies with the amount of stimulus. If a weak electric current is sent along the vagus nerve of a rabbit no actual stoppage occurs, but only a lengthening of the pause between the beats. With a stronger current the heart stops in diastole for a varying period. The inhibitory effect of the vagus overcomes the rhythmical action of the cardiac ganglia. Atropin (the active principle of belladonna) overcomes the inhibitory power of the vagus by paralysing its peripheral terminations in the heart.

The inhibitory action of the vagus nerve may also be brought about by reflex action. A blow in the abdomen, for instance, may cause a nervous shock which, by transmission down the vagus, stops the heart. Sudden emotional influences, as in fainting, may stop the heart, the stimulus being carried along the vagus nerve; while other emotional influences may paralyse the inhibitory apparatus and cause violent palpitation.

The vagus nerves arise from a particular part of the medulla, known as the *cardio-inhibitory centre*, through which they are brought in relationship with other parts of the nervous system.

An increase of the arterial blood pressure is followed by a slowing of the pulse. This slowing of the pulse only occurs when the vagus nerves are intact. We may, therefore, infer that the result is due to the high blood pressure stimulating the cardio-inhibitory centre, and thus partially inhibiting the heart. A low blood pressure, on the other hand, leads to a quickening of the pulse, by a reversed mechanism.

(To be continued.)

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The Discipline of the Mind.

BY W. C. COUPLAND, M.A., B.SC.,

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VII.—The Formation of Habits and Character.

The whole process of Education may be described as a formation of habits, for the ideal of the Educator is a spiritual organism, whose operations are spontaneous without being irregular, free from hesitation and doubt, but correctly responsive to every call. The scene of conscious effort is for ever shifting, and we pass on to fresh conquests, trusting to the self-sustaining power of the system to keep our action true, even when in strictest parlance we know not what we do. The supreme office of volition, indeed, is to bring about its own effacement; for nothing is really well done, no virtue is ever really such, until the act has become automatic, the excellence second nature. We take infinite pains at first to bring all our energies to bear upon some special task, and, as the effort is prolonged and renewed, gradually experience a sense of diminished strain, until at last we find ourselves in the possession of powers which once seemed utterly beyond our wildest hopes. These remarks apply to every region of mind and every form of activity. The method by which we obtain the simplest manual skill is the same as that whereby the good citizen is fashioned; and here as there the training is only finished when the bare idea of what is to be done is instantly followed by the deed itself. The labour of

acquisition is undoubtedly vastly greater in some cases than in others, but if there be only the rudiments of a faculty to start with, no attainment is utterly to be despaired of.

Dr. Reid wrote: 'No man can show a reason why our doing a thing frequently should produce either facility or inclination to do it. The fact is so notorious, and so constantly in our eye, that we are apt to think no reason should be sought for it, any more than why the sun shines. But there must be a cause of the sun's shining, and there must be a cause of the power of habit.' It is strange for us to read such a passage now. What seemed to Reid so mysterious as to be placed by him on a par with instinct cannot be said any longer to baffle explanation. We find a quite sufficient reason for the force of habit in the capacity of nervous matter to retain the results of frequent stimulation in structural modifications, the extreme form of which is subjectively familiar to us as indissoluble or inseparable Association. The effect of repeated exercise of the same kind is to groove channels, or form connections, in nervous matter, which render the passage of nerve force more easy in future, and thus to minimise that feeling of resistance which we know as effort. That 'inclination' should go along with 'facility' is also patent, for success is always the parent of fresh desire, and diminished obstruction to the realization of our aims is attended with a sense of satisfaction which reacts upon the motor centres.

The establishment of a Habit is a great mental and moral economy. Considering the number of things hourly to be done, we should come but badly off if we were not able to relegate the performance of numerous actions to unconscious centres, if we could not bring the whole force of consciousness to bear upon each novel task. We ought not to fear the reproach of becoming 'machines.' It is the very best thing that can happen to us. The more mental machinery, the larger our sphere of action, the greater our spiritual possibilities. This is not less true in the moral than in the intellectual region. This much indeed is true —virtues are not to be counted off on the fingers like so many books of Euclid, which may be mastered in the few years of school discipline, and the character pronounced complete. Special moral habits undoubtedly may be acquired, and evil tendencies eradicated by careful drill, but the automatism of the moral nature is pervasive, and a character that can be partitioned into its ethical qualities is not usually considered an exalted one. But whilst guarding against the vulgar confusion of propriety with ethical worth, not a word must be said against the gain of moral machinery. To *be* good requires truly a vast preliminary amount of *doing* good, and the struggles are usually attended with distress and intense self-consciousness. It would be, however, to miss the beauty of the ethical life to represent the face of Duty as troubled and anxious to the very last. The highest virtue is *unconscious* virtue; and a nature conscious of its effort and sacrifice is not only repellent, but imperfectly moral.

In entering on the subject of Moral Education in the detail, however, we pass into a region where the difficulties of the practical trainer thicken fast. It would be hard to say in which phase of mind the diversity is greater, in intellectual ability or moral disposition; but it is certain where guidance is easier. It may require very thorough comprehension of the laws of mental growth nicely to adjust the burden to the back in the varied field of intellectual acquisition; but the profoundest psychology will hardly by itself afford the insight needed for coping with the tendencies of the moral nature. There are several reasons for this. In the first place it cannot be said that Theory is here far ahead of Practice. Both Theory and Practice are in a very backward state. Although people have been disputing and preaching about Right and Wrong, and the Conduct of Life, for an indefinite period, it cannot be said that Moral Science is anything like as advanced as Physical and Intellectual Science. Again, although the Art of Instruction is still far from having reached a perfect form, the pains that have been expended upon it have certainly been far greater than those expended on Moral Discipline. This is a natural consequence of the circumstance that tutors rarely possess the entire direction of youth, their office usually being restricted to the culture of the intellect; and *moral* education requires constant drill or a watchful eye, both in and out of season. And even where the opportunity is afforded, the order of mind required for dealing with the moral nature is so far higher than that needed for merely imparting knowledge that, with the limited, not to say low, estimate of the schoolmaster's function which has prevailed hitherto, it would be surprising if the traditional methods possessed any considerable worth. To discipline the emotions and the wills of others effectually requires not merely extraordinary discernment, and the power of re-living the life of youth, but also a rare disinterestedness, which can refrain from giving effect to personal likes and dislikes, and maintain the attitude of an impartial judge and guide. So much depending on the teacher's personal qualities, it is to be feared that rules dealing with the formation of character may degenerate into lifeless precepts, and no good end be served by the endeavour to supply them.

If principles are to be laid down they must be of the broadest possible kind, and the application of them when assented to must be as flexible as possible. Now, there is one broad principle coming to be recognised in moral education, and which it is to be hoped will never be lost sight of again, viz., that the discipline must be natural and not artificial, grounded in relations that are necessary and not arbitrary. Although thus tersely expressed, the principle may not be very apparent, a slight paraphrase will show that we are going to the root of a very important subject. I postulate that education is to be thoroughly *real*. I assume that the business of the teacher is to fit the pupil to be a capable and worthy being *in this human life*. Considering the wide differences of opinion on topics that are subsumed under the term Religion or Theology, in dealing with education as a *science*, no other ground than this is permissible. If the public teacher be once allowed to overstep the limits of the *real* world, there is no possibility of coming to any general agreement on the subject of education. It is the business of the schoolmaster to see that the child entrusted to him assimilates *positive* knowledge, and is rendered capable of being an efficient member of a society whose existence is beyond dispute. Practically, he has to be made a worthy citizen, fitted to add to the world's wealth, and to contribute his mite to further the welfare and happi-

ness of humanity. What is the corollary from this? That those things must be regarded as virtues which tend to accomplish these ends, those things must be held to be vices which are likely to be impediments to the same. And the kind of discipline is strictly conditioned by these considerations. As the school is only a preparation for a *real* world, so the *kind* of discipline which will there hold him to his duty should be here employed in miniature. The good and ill fortune he will there encounter will be (so far as personal conduct is concerned with it) the infallible consequence of his conduct; so in the school, cause and effect must be equally necessary, if the school is to be, as it should be, a place of rehearsal, or a drill-ground.

(To be continued.)

ANSWERS TO ARITHMETICAL QUESTIONS IN THE 'SCHOLAR' FOR DECEMBER, 1884.

STANDARD III.

A. 1. 9927 + 51.
2. 60,280 + 11.
3. 94,732 + 25.

B. 1. 721,756,999,560.
2. 61,627 + 18.
3. 11,003 + 563.

C. 1. £11,795 5s. 7¾d.
2. £17,070 7s. 8d.
3. £160,278 11s. 8¾d.

D. 1. £9198 17s. 7½d.
2. £184 1s. 4½d.
3. £6,990,816 18s. 0¾d.

E. 1. £909 14s. 5¾d.
2. £7 8s. 7¾d.
3. £8207 2s. 10¾d.

STANDARD IV.

A. 1. 26,409 ft.
2. 6,744 lbs.
3. £534 9s. 9d.

B. 1. 1294 yds. 4 ft. 899 in.
2. 9,460,848 min.
3. £1 15s. 1½d.

C. 1. £5 17s. 0½d. + 127.
2. 3 mls. 4 fur. 33 po. 3½ yds.
3. 84 packets.

D. 1. £239,203 16s. 7½d.
2. 1,221,120 min.
3. 3,300 pieces.

E. 1. 133,947 ft.
2. 2,344,770 galls. 1 gill
3. £200 14s. 3½d.

STANDARD V.

A. 1. 22½ days.
2. £193 12s.
3. £83 14s. 6d.

B. 1. £219 0s. 1d.
2. £32 5s. 9d.
3. £342 18s. 8d.

C. 1. 44 yds. 2 qrs. 2 nls. 0 in. + 81.

D. 1. £90 17s. 6d.
2. £204 10s. 11d.
3. $1\frac{11}{12}\frac{8}{3}$.
4. $1\frac{7}{11}\frac{7}{9}$.
5. $\frac{13}{17}\frac{3}{2}$.

E. 1. 22½ mls.
2. £170 2s. 6¾d.
3. £180 6s. 7½d.

STANDARD VI.

A. 1. 480 hours.
2. 20·703125.
3. $1\frac{3}{16}$.

B. 1. 133⅓ tons.
2. (*a*) $\frac{77}{144}$; (*b*) $\frac{11}{2016}$; (*c*) $8\frac{7}{8}$.
3. $3\frac{9}{32}$.

C. 1. 9 days.

D. 1. 19½.
2. £2 16s. 3d.
3. 2s. $1\frac{5}{19}$d.

E. 1. 6⅔ days.
2. $2\frac{189}{625}$.
3. £388,600.

STANDARD VII.

A. 1. 5 per cent.
2. £105.
3. 4s. 6d.

B. 1. 8s. 4d.
2. £216·4948...
3. ½ or ·5.

C. 1. 20 p. c. more, and 16⅔ per cent. less.
2. 15s. 2½d.
3. £2400, 4½ per cent.

D. 1. 30 per cent.; 17½ per cent.; and 52½ per cent.
2. £50.
3. $1\frac{1}{19}\frac{4}{8}\frac{4}{8}$.

E. 1. 6637 ac. 2 ro.
2. £1801 14s. 3¾d.
3. 15,800.

Publications Received.

Bell (G.) and Sons—
Bell's Books for Young Readers.

Blackie and Son—
In Freedom's Cause. By G. A. Henty.
True to the Old Flag. By G. A. Henty.
St. George for England. By G. A. Henty.
Traitor or Patriot? By Mary C. Rowsell.
The Wreck of the *Nancy Bell*. By J. C. Hutcheson.
Algebra. Part II.
Pinkerton's Trigonometry.
Bunyip Land. By G. Manville Fenn.
Menhardoc. By G. Manville Fenn.
Magna Charta Stories. By A. Gilman.

Cassell and Co., Limited—
Cassell's Modern School Copy Books. Nos. 1 to 12.

Chambers (W. and R.)—
Chaucer: The Tale of the Man of Lawe (with Notes).

Falconer (John)—
Civil Service Copy and Exercise Books. Nos. 1 to 7.

Heywood (John)—
John Heywood's Combined Writing and Rudimentary Drawing Copy Book.

Hodder and Stoughton—
There's a Friend for Little Children. By J. F. Armstrong.
The Two Sisters. By L. T. Meade.
Scarlet Anemones. By L. T. Meade.
The Story of the Life of Jesus.
Story after Story.
Cheerful Sundays.
The Children's Pastime. By Lisbeth G. Séguin.
The Spitalfields Genius. By J. Fayle, B.A.
Stanley Grahame. By Gordon Stables, M.D., R.N.
The Children's Portion. By A. Macleod, D.D.
Charity Moore.
Daisy Snowflake's Secret. By Mrs. G. S. Reaney.
The Mothers' Friend. Vol. XVI.

Hodgson (F.)—
An Introduction to Geometry. By J. Walmsley, B.A.
The State and Education. By C. H. Schaible, Ph.D., M.D., F.C.P.

Isbister (W.), Limited—
The Sixth Natural History Reader. By Rev. J. G. Wood, M.A.

Johnston (W. and A. K.)—
Johnston's Illustrations of Chemistry. Sheets No. 1 and 2 (with Handbooks).
Map of the Holy Land (with Handbook).
Eskimo Family.
The Chinese.
The Golden Eagle.

Letts, Son, and Co.—
Letts's Illustrated Household Magazine for November.

Longmans and Co.—
Readings in Social Economy. By Mrs. F. Fenwick-Miller.
Historical Biographies. By S. R. Gardiner.
Longman's Magazine for November.
Longman's Magazine. Christmas Number, 1884.

Marshall (J.) and Co.—
The Infant Action Song and Recitation Book.
Time Tables.

Midland Educational Trading Company, The—
The Albion Block Face for Infants' Schools.

Murby (T.)—
Notes on Elementary Physiography. By W. S. Furneaux.
Shaksperian Characters Delineated. By W. Weeks.
Langton's Examples in Arithmetic.

National Society, The—
The Childhood of Christ (Picture Card).

Nelson (T.) and Sons—
Primary History of England.
Intermediate History of England.
Advanced History of England.

Reeves (Wm.)—
The Peer and the Prophet.

Smith, Elder, and Co.—
The Cornhill Magazine for November.

Stewart and Co.—
History of Philosophy. By Dr. Morrell.
The Divine Interpretation of Scripture.

Stock (Elliot)—
Mottoes and Motives.

Wyman and Sons—
First Lessons in English Grammar. By S. E. Querini.

Query Column.

RULES.

1. Each correspondent is restricted to *one question*. We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.

2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.

3. ☞ **When a pseudonym is adopted it should be written at the end of the query, and the real name and address on a separate piece of paper.**

4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.

5. Replies will not be sent through the post.

6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—'*The Query Editor*,' *The Practical Teacher*, *Pilgrim Street, Ludgate Hill, London, E.C.*

Algebra.

1. ALPHA C.—Solve :—

$$1-\frac{x}{2}\left(1-\frac{3}{4x}\right)=\frac{3}{8}\left(3-\frac{5x}{2}\right)+5\tfrac{13}{16}.$$

(*Colenso.*)

$$1-\frac{x}{2}\left(1-\frac{3}{4x}\right)=\frac{3}{8}\left(3-\frac{5x}{2}\right)+5\tfrac{13}{16}$$

$$1-\frac{x}{2}\left(\frac{4x-3}{4x}\right)=\frac{3}{8}\left(\frac{6-5x}{2}\right)+\tfrac{213}{240}$$

$$1-\frac{4x-3}{8}=\frac{6-5x}{3}+\tfrac{213}{240}$$

$$120-60x+45=240-200x+639$$
$$200x-60x=879-165$$
$$140x=714$$
$$\therefore\ x=\tfrac{714}{140}$$
$$=5\tfrac{1}{10}.$$

2. INQUISITIVE.—A farmer sold on one day 2 oxen and 3 sheep for £34 10s., and 4 oxen and 5 sheep for £67 10s., and 6 oxen and 7 sheep for £100. Can he have sold all the oxen at one rate and all the sheep at one rate? (*Edinburgh University*, 1884.)

If the oxen were sold at one rate, and the sheep at one rate, and if x and y represent the values of an ox and a sheep, respectively, in pounds, then

$$\left.\begin{array}{l}(1)\ 2x+3y=34\frac{1}{2}\\(2)\ 4x+5y=67\frac{1}{2}\\(3)\ 6x+7y=100\end{array}\right\}$$
$$\left.\begin{array}{l}(1)\ 4x+6y=69\\(2)\ 4x+5y=67\frac{1}{2}\end{array}\right\}$$
$$\therefore\ y=1\tfrac{1}{2}.$$
$$\left.\begin{array}{l}(1)\ 6x+9y=103\frac{1}{2}\\(3)\ 6x+7y=100\end{array}\right\}$$
$$2y=3\tfrac{1}{2}$$
$$\therefore\ y=1\tfrac{3}{4}.$$

∴ The oxen and sheep were *not* sold at one rate.

3. SUBSCRIBER.—Find m in terms of n if

$$a^{m^n}=\left(a^m\right)^n.$$

(*Hamblin Smith.*)

$$a^{m^n}=\left(a^m\right)^n,$$
$$a^{m^n}=a^{mn},$$

Taking m^{th} root

$$a^{m^{n-1}}=a^n,$$
$$a^m=a^{n^{\frac{1}{n-1}}};$$
$$\therefore\ m=n^{\frac{1}{n-1}}.$$

4. MOTHER LOUISE.—Solve :—

$$x^2+y=7,\ y^2+x=11.$$
$$\left.\begin{array}{l}(1)\ x^2+y=7\\(2)\ y^2+x=11\end{array}\right\}$$

From (1), $y=7-x^2$;

$$\therefore\quad (2)\quad (7-x^2)^2+x=11$$
$$49-14x^2+x^4+x=11$$
$$x^4-14x^2+x+38=0$$
$$(x-2)(x^3+2x^2-10x-19)=0;$$

If, $x-2=0$, then $x=2$.

If, $x^3+2x^2-10x-19=0$, we have a cubic equation for solution.

To eliminate the second term assume $x=z-\frac{2}{3}$.

Then, $(z-\frac{2}{3})^3+2(z-\frac{2}{3})^2-10(z-\frac{2}{3})-19=0$

$$z^3-2z^2+\tfrac{4}{3}z-\tfrac{8}{27}+2z^2-\tfrac{8}{3}z+\tfrac{8}{9}-10z+\tfrac{20}{3}-19=0$$
$$z^3-\frac{34z}{3}-\tfrac{317}{27}=0,$$

In the equation, $x^3+qx+r=0$, by Cardan's process,

$$x=\left(-\frac{r}{2}+\sqrt{\frac{r^2}{4}+\frac{q^3}{27}}\right)^{\frac{1}{3}}+\left(-\frac{r}{2}-\sqrt{\frac{r^2}{4}+\frac{q^3}{27}}\right)^{\frac{1}{3}};$$

Here, $r=-\frac{317}{27}$, $q=-\frac{34}{3}$;

Hence,

$$z=\left(\frac{317}{27\times 2}+\sqrt{\frac{(\frac{317}{27})^2}{4}-\frac{(\frac{34}{3})^3}{27}}\right)^{\frac{1}{3}}$$
$$+\left(\frac{317}{27\times 2}-\sqrt{\frac{(\frac{317}{27})^2}{4}-\frac{(\frac{34}{3})^3}{27}}\right)^{\frac{1}{3}}$$
$$=(\tfrac{317}{54}+\sqrt{\tfrac{100489}{2916}-\tfrac{39304}{729}})^{\frac{1}{3}}$$
$$+(\tfrac{317}{54}-\sqrt{\tfrac{100489}{2916}-\tfrac{39304}{729}})^{\frac{1}{3}}$$
$$=(\tfrac{317}{54}+\tfrac{1}{54}\sqrt{-56727})^{\frac{1}{3}}$$
$$+(\tfrac{317}{54}-\tfrac{1}{54}\sqrt{-56727})^{\frac{1}{3}};$$

Now, as $\frac{r^2}{4}+\frac{q^3}{27}$ is a negative quantity, all the roots are real and unequal, and Cardan's solution of a cubic equation is of little practical use. For in this case the values of z are imaginary; and although we know that cube roots of these expressions exist, there is no arithmetical method of obtaining them, and no algebraical method of obtaining them exactly. We have the roots exhibited in a form which is algebraically correct, but arithmetically of little value. (See *Todhunter's* 'Theory of Equations.')

∴ The only integral solution is $x=2$, and $y=7-x^2=3$.

5. PRÆCEPTOR.—Solve :—

$$\left.\begin{array}{l}\frac{x}{a+b}+\frac{y}{a-b}=2a\\\frac{x-y}{2ab}=\frac{x+y}{a^2+b^2}\end{array}\right\}$$ (*Todhunter.*)

$$\left.\begin{array}{ll}(1)&\frac{x}{a+b}+\frac{y}{a-b}=2a\\(2)&\frac{x-y}{2ab}=\frac{x+y}{a^2+b^2}\end{array}\right\}$$

$$(2)\ (a^2+b^2)x-(a^2+b^2)y=2abx+2aby$$
$$(a^2-2ab+b^2)x=(a^2+2ab+b^2)y$$
$$(a-b)^2x=(a+b)^2y$$
$$\therefore y=\frac{(a-b)^2x}{(a+b)^2}$$

(1) $\frac{x}{a+b}+\left\{\frac{(a-b)^2x}{(a+b)^2}\times\frac{1}{a-b}\right\}=2a$

$$\frac{x}{a+b}+\frac{(a-b)x}{(a+b)^2}=2a$$
$$(a+b)x+(a-b)x=2a(a+b)^2$$
$$2ax=2a(a+b)^2$$
$$\therefore x=(a+b)^2.$$
$$y=\frac{(a-b)^2x}{(a+b)^2}=\underline{(a-b)^2}.$$

6. ALICE M. M. DUNN.—Solve:—

$$1+\sqrt{1-\frac{a}{x}}=\sqrt{1+\frac{x}{a}}. \quad (Todhunter.)$$
$$1+\sqrt{1-\frac{a}{x}}=\sqrt{1+\frac{x}{a}}$$
$$1=\sqrt{1+\frac{x}{a}}-\sqrt{1-\frac{a}{x}}$$
$$1=\sqrt{\frac{a+x}{a}}-\sqrt{\frac{x-a}{x}}$$

Squaring, $1=\frac{a+x}{a}-2\sqrt{\frac{(a+x)(x-a)}{ax}}+\frac{x-a}{x}$

$$1=1+\frac{x}{a}-2\sqrt{\frac{x^2-a^2}{ax}}+1-\frac{a}{x}$$
$$\left(\frac{x}{a}-\frac{a}{x}\right)-2\sqrt{\frac{x^2-a^2}{ax}}+1=0$$
$$\frac{x^2-a^2}{ax}-2\sqrt{\frac{x^2-a^2}{ax}}+1=0$$

Extracting square root, $\sqrt{\frac{x^2-a^2}{ax}}-1=0$

$$\sqrt{\frac{x^2-a^2}{ax}}=1$$
$$x^2-a^2=ax$$
$$x^2-ax=a^2$$
$$x^2-ax+\left(\frac{a}{2}\right)^2=a^2+\frac{a^2}{4}$$
$$=\frac{5a^2}{4}$$
$$x-\frac{a}{2}=\frac{\pm a\sqrt{5}}{2}$$
$$x=\frac{\pm a\sqrt{5}}{2}+\frac{a}{2}$$
$$\therefore x=\underline{\frac{a(\pm\sqrt{5}+1)}{2}}.$$

7. UNITY.—Solve:—

$$\frac{bx}{a}-\frac{d}{c}=\frac{a}{b}-\frac{cx}{d}. \quad (Jones\ and\ Cheyne.)$$
$$\frac{bx}{a}-\frac{d}{c}=\frac{a}{b}-\frac{cx}{d}$$
$$\frac{bx}{a}+\frac{cx}{d}=\frac{a}{b}+\frac{d}{c}$$
$$\frac{bdx+acx}{ad}=\frac{ac+bd}{bc}$$
$$\frac{(ac+bd)x}{ad}=\frac{ac+bd}{bc}$$
$$\frac{x}{ad}=\frac{1}{bc}$$
$$\therefore x=\underline{\frac{ad}{bc}}.$$

8. J. W. H.—Write down the coefficient of x^r in the expansion of $(1-x)^{-4}$. (*Todhunter.*)

As x and the exponent are both negative, the terms are all positive.

$\therefore$ Coefficient of x^r

$$=\frac{4(4+1)(4+2)\ldots(4+r-1)}{\lfloor r}$$
$$=\frac{4.\ 5.\ 6\ldots(r+3)}{\lfloor r}$$
$$=\underline{\frac{(r+1)(r+2)(r+3)}{\lfloor 3}}. \quad \text{Ans.}$$

9. CYCLOPS.—Solve the equation:—

$$\left.\begin{aligned}xyz&=231\\xyw&=420\\yzw&=1540\\xzw&=660\end{aligned}\right\}\ (Winchester\ College\ Election,\ 1882.)$$

Multiplying all together $x^3y^3z^3w^3=231\times420\times1540\times660$

$$=7\times11\times3\times7\times3\times20\times7\times11\times20\times3\times11\times20$$
$$=7^3\times11^3\times3^3\times20^3$$
$$xyzw=7\times11\times3\times20$$
$$=4620;$$
$$w=\frac{4620}{231}=20;\ z=\frac{4620}{420}=11;$$
$$x=\frac{4620}{1540}=3;\ y=\frac{4620}{660}=7.$$

10. UNITY.—Solve:—

$$\frac{4x}{5-x}-\frac{20-4x}{x}=15. \quad (Mansford.)$$
$$\frac{4x}{5-x}-\frac{20-4x}{x}=15$$
$$\frac{4x}{5-x}-\frac{20}{x}+4=15$$
$$\frac{4x}{5-x}-\frac{20}{x}=11$$
$$4x^2-20(5-x)=11x(5-x)$$
$$4x^2-100+20x=55x-11x^2$$
$$4x^2+11x^2+20x-55x=100$$
$$15x^2-35x=100$$
$$x^2-\frac{7x}{3}=\frac{20}{3}$$
$$x^2-\frac{7x}{3}+\left(\frac{7}{6}\right)^2=\frac{20}{3}+\frac{49}{36}$$
$$=\frac{240+49}{36}$$
$$=\frac{289}{36}$$
$$x-\frac{7}{6}=\pm\frac{17}{6}$$
$$x=\pm\frac{17}{6}+\frac{7}{6}$$
$$\therefore \underline{x=4,\ \text{or}\ -\tfrac{5}{3}}.$$

11. F. HOLTON.—If $x^{-1}=(a-c)(b-c)$

$$y^{-1}=(a-b)(b-c)$$
$$z^{-1}=(a-b)(a-c),$$

find the values of $x-y+z$ and $abx-acy+bcz$. (*Colenso.*)

(1) $x^{-1}=(a-c)(b-c)$
(2) $y^{-1}=(a-b)(b-c)$
(3) $z^{-1}=(a-b)(a-c)$

(1) $\frac{1}{x}=(a-c)(b-c)$
(2) $\frac{1}{y}=(a-b)(b-c)$
(3) $\frac{1}{z}=(a-b)(a-c)$

(1) $x=\frac{1}{(a-c)(b-c)}$
(2) $y=\frac{1}{(a-b)(b-c)}$
(3) $z=\frac{1}{(a-b)(a-c)}$

$$\therefore x-y+z=\frac{1}{(a-c)(b-c)}-\frac{1}{(a-b)(b-c)}+\frac{1}{(a-b)(a-c)}$$
$$=\frac{(a-b)-(a-c)+(b-c)}{(a-b)(a-c)(b-c)}$$
$$=\frac{a-b-a+c+b-c}{(a-b)(a-c)(b-c)}$$
$$=\underline{0}$$

$$\therefore abx-acy+bcz=\frac{ab}{(a-c)(b-c)}-\frac{ac}{(a-b)(b-c)}+\frac{bc}{(a-b)(a-c)}$$
$$=\frac{ab(a-b)-ac(a-c)+bc(b-c)}{(a-b)(a-c)(b-c)}$$
$$=\frac{a^2b-ab^2-a^2c+ac^2+b^2c-bc^2}{(a-b)(a-c)(b-c)}$$
$$=\frac{a^2b-ab^2-abc+b^2c-a^2c+ac^2+abc-bc^2}{(a-b)(a-c)(b-c)}$$
$$=\frac{ab(a-b)-bc(a-b)-ac(a-c)+bc(a-c)}{(a-b)(a-c)(b-c)}$$
$$=\frac{b(a-b)(a-c)-c(a-b)(a-c)}{(a-b)(a-c)(b-c)}$$

$$= \frac{(a-b)(a-c)(b-c)}{(a-b)(a-c)(b-c)}$$
$$= 1.$$

or, $$\frac{a^2b - ab^2 - a^2c + ac^2 + b^2c - bc^2}{(a-b)(a-c)(b-c)}$$
$$= \frac{a^2b - ab^2 - a^2c + ac^2 + b^2c - bc^2}{a^2b - ab^2 - a^2c + ac^2 + b^2c - bc^2}$$
$$= 1.$$

12. BOIS GILBERT.—How many different divisors will a number have which is the product of n different prime numbers? (*3rd Stage, Science and Art Christmas Paper*, 1884.)

No. of divisors (including unity and the number itself)

$$= 1 + n + \frac{n(n-1)}{1.2} + \frac{n(n-1)(n-2)}{1.2.3} + \ldots + 1;$$

$$(1+1)^n \text{ or } 2^n$$

$$= 1 + n + \frac{n(n-1)}{1.2} + \ldots + 1;$$

∴ No. of divisors (including unity and the number itself) $= 2^n$.

General.

1. E. H. COUMBE.—(1) The solution of your query appeared in our issue for February, 1882. (2) Perhaps 85 per cent.

2. R. W. PEARSON.—You will find the solution of your query in our issue for April, 1883.

3. M. R. S.—Your query was solved in our issue for November, 1882.

4. AGONISTES.—Either Knight's or Burchett's. Both are capital manuals.

5. DOUBTFUL.—As you say, the question is meaningless. The inspector evidently intends the answer to be 10, as you show in your postscript; but as half of the boys win, it is absurd to ask for the average loss of all. Further comment on the sum is needless, and we will not attempt its solution.

6. E. KIRK.—The rider was solved in our issue for March, 1883.

7. MAGPIE.—You will find the solution of your query in our issue for May, 1882.

8. C. S. J.—(*a*) The solution of your query (by arithmetic) appeared in our last issue. (*b*) We believe your writing will obtain full marks. (*c*) *Amner's* 'Notes of Lessons, and How to Write Them' (*Moffatt and Paige*), and 'The Handy Book of Object Lessons' (two series), published by *Jarrold and Sons*.

9. MAGISTER.—You will find the solution of your question in our last issue.

10. XMAS.—The solution given is quite correct. The second and third cases must be considered *apart* from the first. In the second case we have the rate of steaming and the rate of walking in one direction, and the rate of the tide in the other. In the third case we have the rate of steaming in one direction, and the rate of walking and the rate of tide in the other. We trust that the explanation is satisfactory.

11. T. H.—Your equation is exactly similar to that of 'Mother Louise' (No. 4, Algebra, in this issue).

12. T. R.—You will find the solution of your query in our ssue for August, 1882.

13. BRADFORD.—The solution of your query appeared in our issue for March, 1883.

14. EUPHONISM.—We should think 'Lily Agnes Best.'

15. M. G.—Apply to the nearest certificated teacher.

16. OMAI.—The Latin lessons will shortly be resumed in the PRACTICAL TEACHER. Writing is 'Good.'

17. FRIDAY.—Of course not. Who told you so?

18. SPERO.—Surely there is some competent teacher at hand. If so, go to him. It would be much the best; but if it is impossible, adopt the plan you mention. You ought not to be left to yourself. Your penmanship and composition need careful attention.

19. ENCRINITE.—You are, no doubt, aware that several important works on geology have recently been published, notably *Geikie's* 'Textbook,' *and Green's*. You will find some papers and lectures in the last ten volumes of 'Nature.' You will, of course, refer to the reports of the proceedings of the Geological Society.

20. CHEMIST.—Before analysing the beer at your lecture, we advise you to rehearse the experiment several times at home. You do not say what your object is. If you want to show the smallness of the solid residue, evaporate over a small steam bath equal quantities of beer and milk, and compare and contrast the results. To show the presence of alcohol, distil and collect the part that comes out first; blotting paper dipped in this will burn; the presence of the alcohol can also be shown by the reduction of bichromate of potash. It would perhaps be advisable to exhibit the constituents in case the analysis does not succeed.

21. APOLLO.—Write to the registrar, Burlington House, Piccadilly. A syllabus will be sent to you. You will find in it all the information you require.

22. BLADE.—For an account of winds and ocean currents, suitable for third year's pupil teachers, try *Murby's* 'Physiography,' and *Findlater's* 'Physiography.' Etymology implies the knowledge of a certain number of roots, as they are called, and the force of prefixes and affixes. A full account of all you ask will be found in Morris. See 45 below.

23. XMAS.—The certificate questions are published, and may be obtained from Messrs. Chapman and Hall, Henrietta Street, or through any bookseller.

24. MAGISTER.—Try *Hughes's* 'Standard Story Books.'

25. B. FRENCH.—Many grammars contain useful information. They are reliable enough; but they all need supplementing by lessons from some one who knows how to speak French. It is impossible to acquire a correct pronunciation from reading a book. You may profitably turn to *Cassell's* 'Lessons in French,' *De Lolme* and *Fasnacht's* 'Synthetic French Grammar' (Macmillan).

26. G. R. T.—For a manual on building construction, suitable for young pupil. See *Collins'* Series.

27. L. G. W.—Candidates who are taking second year's papers will have the usual examination, which includes both the subjects you name.

28. EDWAL.—Try *Deschanel's* 'Natural Philosophy,' Parts II. and IV. (Blackie and Co.). The syllabus is usually ready in December. It is not to be purchased until some time later. It changes but little from year to year. You can assume that the one in force will continue much as it is. The syllabus for 1884, and the questions set at Christmas, 1883, can be procured through any bookseller, price 6d.

29. URARI.—*Hewitt's* 'Colonies,' *Curtis's* 'Outline of English History,' 'Epochs of English History' (Longmans), *Curwen's* 'Commonplaces of Music,' Part B., 1s. 6d.; 'Standard Course,' 3s. 6d. Add *Jevons'* 'Primer of Political Economy,' 1s.

30. HEATHFIELD.—The syllabus is in the 'Code.'

31. FARLIGH.—Both specimens are too upright, and the strokes too uneven, the curves too flat. Practise greater slope.

32. INTERESTED.—Under Art. 79, any person approved by the inspector has a permanent qualification.

33. BELLA.—You seem entitled to it: communicate with the secretary of the National Union of Elementary Teachers, 59, Chancery Lane.

34. G. F. B.—(1) By permission of the principal. (2) 65.

35. VALE OF LLANGOLLEN.—Writing legible, but by no means elegant. It is too upright, and the letters are badly formed.

36. BRIEF.—Stiff, but legible; letters well formed. 85.

37. SILURIAN.—70.

38. J. GUILD.—This is a matter which is settled in the Council office. We have no authentic information, nor can you get any.

39. BLACKBOARD. — The title of honorary certificated teacher is new to us. Explain it, and repeat your query.

40. VOX.—We know of no small book containing what you want, but you can find enough in any good history.

41. NANCE.—We believe there is none. You will find it very helpful to read the other parts of the work : one part explains the other.

42. GRÆCA.—*Xenophon's* 'Hellenics,' by *Hailstone* (Macmillan).

43. CROMWELL.—Consult any good history.

44. TUTOR.—We dont know of an annotated edition of the English works, nor a translation of Feugère. For *Racine's* 'Esther' consult Bohn's translation.

45. R. H. D.—Turn to 'Elementary Lessons in Historical English,' by *Dr. Morris* (Macmillan), 2s. 6d. (p. 27).

46. D. E. F.—You can satisfy the conditions of ordinary mental acquirement; study when you are well nourished, not when you are faint; give the most wrapt attention possible to your work; don't attempt too much, think frequently about it afterwards. Some people find systems of mnemonics useful; we have not.

We always attend to the requests of private students. For mathematical query see Rule I.

47. GENTIL.—You must state exactly where your difficulty is, or we cannot help you. Avogadro's hypothesis is now found to be a direct consequence of the kinetic theory of gases. A full but not very easy account of this theory will be found in *Maxwell's* 'Heat,' page 316. But the law may be considered as established by the relations between the combining proportions of the elements by weight and by volume. One volume of oxygen unites with two volumes of hydrogen to form two volumes of water vapour. The weight of a volume of oxygen is sixteen times that of a volume of hydrogen, and the weight of a volume of water vapour nine times. It is reasonable to suppose that a molecule of O, and two molecules of H, give rise to two molecules of OH_2; but as two volumes of H unite with one of O, there must have been twice as many molecules of H in two volumes as of O in one; *i.e.*, that equal volumes contain an equal number of molecules at the same temperature and pressure. See 'Chemical Theory,' by *Ramsay* (Macmillan).

Repeat your equation; you have not given it correctly.

48. NO NAME.—The fable of the darkness is probably due to the long, dark winters of the northern latitudes. Cf. Hayman, vol. ii.; *Merry*, large edition; and *Gladstone's* 'Juventus Mundi,' vol. iii.

The idea of a living man penetrating the unseen world, and coming back to tell its secrets, is a figment of early poetic imagination. This natural curiosity found satisfaction in poetry.

49. T. H. C. SHAW.—What edition of *Orme's* 'Heat' are you using? On turning to the book, page 17, we find the sum you have sent worked out in full. The answer you sent is not correct, nor did you state that two co-efficients of expansion were used (page 16).

1 c.m. at O°C becomes 1·00086 at 100°C.
and 1 c.m. at 100°C ,, 1·00092 at 200°C.
∴ 1 c.m. at O°C ,, 1·00086 × 1·00092 at 200°C.
and ∴ 13 c.m. at O°C ,, 1·00086 × 1·00092 × 13.
= 13·023149.

50. MACBETH.—A, 60. B, 70.

51. EDINBURGH.—The manuals by Roscoe and Fownes will be found suitable for all the examinations you name.

52. G. R. T.—Try the manual in *Collins'* series.

53. BETZ.—There is no such problem as you send on page 104 in either of Todhunter's books. Give correct reference, and repeat your query.

54. PUPIL TEACHER.—(1) Ask kindly and politely for a change. (2) How do you know you can claim anything? (3) By passing the examinations. (4) Early next year. We know of none.

55. DOCEO.—Article 12 (*d*) of the Code distinctly states:—'The class registers must be marked and finally closed *before* the *minimum* time constituting an attendance begins. If any scholar entered in the register is withdrawn from school before the time constituting an attendance is complete, the entry of attendance should be at once cancelled.' The attendances of the pupils leaving the school for music lessons *must*, therefore, be cancelled.

56. X. Y. Z.—The query you send is imperfect. Both statements are the same, viz., that the first number is $\frac{3}{5}$ of the second, and therefore any multiples of 3 and 5 satisfy the conditions. The attention of the publishers should be called to the question.

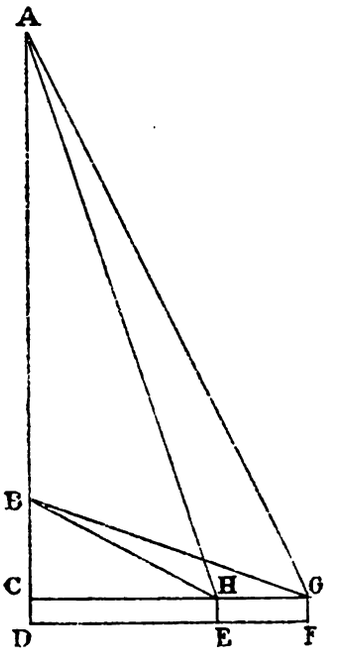
57. TROUBLESOME.—(1) The second part of your deduction was given in our issue for March, 1883, and in the proof the demonstration of the first part appears. (2) No.

58. ASSISTANT MISTRESS.—You will find the solution of your query in our issue for December, 1882.

59. SILURIAN.—The solution of your query appeared in our issue for June, 1882.

60. JOHN YARKER.—*But*, primarily a conjunction, may, like most other English words, be used as other parts of speech—*e.g.*, as preposition, adverb, and noun. In the sentence, 'The valiant only taste of death but once,' by analogy, and by reference to the preceding sentence, we think *but* clearly means *only*, *simply*, or *not more than*. As such it can only be an adverb. Had it said *very often*, *very* would have been an adverb of degree, and we are of opinion that *but* is the same. Suppose you wish to call *but* a conjunction, then you get the sentence, 'The valiant only taste of death, but they taste of death once!' The sentence is not complete; it needs the adverb *only*, to which we think 'but' is equivalent. In every sentence words must be parsed singly, and in accordance with their use. *But once* is an adverbial phrase, but *but* alone is an adverb.

61. E. J. B. and J. P., BARLESTONE.—A column standing on a pedestal 25 ft. 6 in. high subtends an angle of 45° at the eye of an observer, who stands on the horizontal plane from which the pedestal springs. When the observer approaches 20 ft. nearer to the column, it again subtends an angle of 45° at his eye. Find the height of the column, supposing the height of the observer's eye above the plane to be 5 ft. 6 in. (*Todhunter.*)



$$\text{Tan AHC} = \text{Tan (AHB + BHC)}$$

$$\frac{AC}{CH} = \frac{\text{Tan AHB} + \text{tan BHC}}{1 - \text{tan AHB. tan BHC}}$$

$$\frac{AB + BC}{CH} = \frac{\text{Tan } 45^\circ + \frac{BC}{CH}}{1 - \text{tan } 45. \frac{BC}{CH}}$$

$$\frac{AB+20}{CH}=\frac{1+\frac{20}{CH}}{1-\frac{20}{CH}}$$

$$\therefore \frac{AB+20}{CH}=\frac{CH+20}{CH-20}.$$

$$\text{Tan AGC}=\text{Tan (AGB}+\text{BGC)}$$

$$\frac{AC}{CG}=\frac{\text{Tan AGB}+\text{tan BGC}}{1-\text{tan AGB. tan BGC}}$$

$$\frac{AB+BC}{CH+HG}=\frac{\text{Tan } 45^\circ+\frac{BC}{CG}}{1-\text{tan } 45.\frac{BC}{CG}}$$

$$\frac{AB+20}{CH+EF}=\frac{1+\frac{20}{CH+EF}}{1-\frac{20}{CH+EF}}$$

$$\frac{AB+20}{CH+20}=\frac{1+\frac{20}{CH+20}}{1-\frac{20}{CH+20}}$$

$$=\frac{CH+20+20}{CH+20-20}$$

$$\therefore \frac{AB+20}{CH+20}=\frac{CH+40}{CH}.$$

(1) $\frac{AB+20}{CH}=\frac{CH+20}{CH-20}$

(2) $\frac{AB+20}{CH+20}=\frac{CH+40}{CH}$

(1) $\frac{AB+20}{CH+20}=\frac{CH}{CH-20}$;

$$\therefore \frac{CH}{CH-20}=\frac{CH+40}{CH}$$

$$CH^2=(CH-20)(CH+40)$$

$$=CH^2+20CH-800$$

$$20CH=800$$

$$\therefore CH=40.$$

(1) $\frac{AB+20}{CH}=\frac{CH+20}{CH-20}$

$$\frac{AB+20}{40}=\frac{40+20}{40-20}$$

$$=\frac{60}{20}$$

$$=3$$

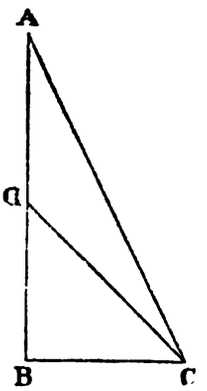
$$AB+20=120$$

$$\therefore AB=100.$$

$\therefore$ Height of column = 100 ft. Ans.

Note.—The handwriting of E. J. B. is *pretty fair*.

62. S. A. W., SMETHWICK.—The upper half of a post, seen from a point on a level with the foot of the post, subtends an angle whose tangent is $\frac{1}{3}$; find the tangent of the angle subtended by the whole post. (*Todhunter.*)



$$\text{Tan ACB}=\text{Tan (ACD}+\text{DCB)}$$

$$=\frac{\text{Tan ACD}+\text{tan DCB}}{1-\text{tan ACD. tan DCB}}$$

$$=\frac{\frac{1}{3}+\frac{DB}{BC}}{1-\frac{1}{3}\cdot\frac{DB}{BC}}$$

$$\therefore \frac{AB}{BC}=\frac{BC+3DB}{3BC-DB}$$

$$\frac{2DB}{BC}=\frac{BC+3DB}{3BC-DB}$$

$$2DB(3BC-DB)=BC(BC+3DB)$$

$$6BC.DB-2DB^2=BC^2+3BC.DB$$

$$BC^2-3BC.DB=-2DB^2$$

$$BC^2-3BC.DB+\left(\frac{3DB}{2}\right)^2=\frac{9DB^2}{4}-2DB^2$$

$$=\frac{DB^2}{4}$$

$$BC-\frac{3DB}{2}=\pm\frac{DB}{2}$$

$$BC=\pm\frac{DB}{2}+\frac{3DB}{2}$$

$\therefore$ BC = 2DB, or DB.

$$\therefore \text{Tan ACB}=\frac{2DB}{BC}$$

$$=\frac{2DB}{2DB}, \text{ or } \frac{2DB}{DB}$$

$$=1, \text{ or } 2.$$

Arithmetic.

1. IMPATIENT.—Find the difference between the simple and compound interest of £150 at 4½ per cent. per annum for 3 years. (*P. T.'s Examination*, October, 1884.)

£150
9
2 | 1350
675
3
£20·25
20
s. 5·00

Simple interest = £20 5s.

£150
9
2 | 1350
£6·75

£156·75
9
2 | 141075
£7·05375

£163·80375
9
2 | 147423375
£7·37116875

£150
6·75
156·75
7·05375
163·80375
7·37116875
171·17491875
150
£21·17491875
20
s. 3·49837500
12
d. 5·98050000

Compound interest = £21 3s. 5$\frac{98}{100}$d.
Difference = £21 3s. 5$\frac{98}{100}$d. − £20 5s.
= 18s. 5$\frac{98}{100}$d. Ans.

2. JERRY.—A boat's crew row over a mile and a quarter against a stream, which flows at the rate of 2 miles an hour, in 10 minutes. The usual rate of the stream is half a mile an hour. Find the time which the boat would take in the usual state of the river. (*Hamblin Smith.*)

They could row $(2-\frac{1}{2})$ miles or 1½ miles more in an hour in the usual state of the river

= ½ of 1½ miles in 10 minutes
= ½ of a mile in 10 minutes;
miles miles min.
$\therefore$ 1½ + ½ : 1½ :: 10 : Time.

$$=\left(\frac{5}{\cancel{2}}\times\frac{\overset{5}{\cancel{10}}}{1}\times\frac{\cancel{2}}{3}\right)\text{ min.}$$

$$=\frac{25}{3}\text{ min.}$$

$$=8\tfrac{1}{3}\text{ min.}$$ Ans.

[*Owing to the great pressure on our space a large number of Queries are held over.*]

The Practical Teacher.

A MONTHLY EDUCATIONAL JOURNAL.

To Subscribers.—The *Practical Teacher* is published on the 25th of every month. Price 6d.; post free, 7½d.; sent post free, three months for 1s. 11d.; six months, 3s. 9d. a year, 7s. 6d.

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Above 20 words and under 32 words ...	4	0
32 words and under 64 words	5	0
For every additional 10 words	1	0

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	s.	d.
20 words or under	1	0
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For 3rd page of wrapper	5 guineas.
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Parts of a page are charged at a slightly higher rate.—Special quotations will be given for a series.

Portfolios, fitted with elastic bands, for preserving twelve numbers of 'The Practical Teacher,' may now be had. Price 2s. 6d. Orders should be given through booksellers.

The numbers of the *Practical Teacher* for February and March, 1884, are now out of print.

Matriculation Hints.

BY HENRY A. REATCHLOUS, M.A. (LOND.), B.Sc.,

Westminster Training College.

THE subject of Hydrostatics often presents peculiar difficulties. There is no royal road through them. The student must try to think patiently, clearly, and attentively. The books previously named contain all that is necessary, and some of them much more. There is also a cheap manual by Galbraith and Haughton, one by Magnus, and the well-known text-book by Besant (Bell and Co.). The first, and perhaps most important, point is to get a correct notion of how pressure is transmitted in a liquid and a gas, and how it varies as with the depth. If a be the area of the base of any vessel, h be the height of the liquid, ρ be the density of it, and g be acceleration due to gravity, then the pressure on the base will be $a\,h\,\rho\,g$ dynes, or $h\,\rho\,g$ dynes per square centimetre. Sea-water has a pretty constant density, and a pressure guage submerged at a constant depth would, by giving us the dynes per square centimetre, afford us a means of comparing the different values of g for different latitudes. No notice was taken of the pressure of the air, which, when the barometer is at 760 mm. is equal to 15 lbs. on the inch, or 1,033 grams per square centimetre, or 1,033 981 dynes per square centimetre. Hence, if this is added, the pressure at any depth of a fluid is $1{,}033 \times 981 + h\,\rho\,g$ dynes per square centimetre.

Suppose a body is floating, partially immersed in water. The other part is immersed in air. The apparent loss of weight of the body is due to the water displaced and the air displaced, the former being, of course, very much the greater of the two. What would happen, then, if a beaker containing a ball floating in water be put under the receiver of an air-pump, and the air exhausted? Obviously the ball would tend to sink; more of it would be immersed in the water.

The syllabus mentions specific gravity, and modes of determining it. The student is specially recommended to determine for himself the specific gravities of a few substances. Take, for instance, a penny; weigh it in air, and then suspend it by a thin wire or fine thread to one scale-pan of a balance, and immerse the coin in pure water. Now weigh it again. The loss of weight is the weight of an equal bulk of water. Hence the specific gravity of the coin $= \frac{\text{weight of coin in air}}{\text{weight of equal vol. of water.}}$ This result, however, needs correction, as the weight of a definite volume of water varies with the temperature. A correction can be made. It is only at 4° C. that the density of water is unity. The temperature of rooms we work in varies from 12° to 20° C. The weight of the equal volume of water is, therefore, a little too small. The density of water at different temperatures has been carefully observed and recorded. If the thermometer stands at 15° C., and the loss of weight in water is 9·9915 grams, the weight of that volume of water at 4° C. would be $\cdot99915 \times \frac{10000}{9915} = 10$ grams.

We give the density of water for the temperatures between 14 and 20. At 14° it is ·99930; at 15°, ·99915; at 16°, ·99915; at 17°, ·99884; at 18°, ·99866; at 19°, ·99847; at 20, ·99827. For perfect accuracy, the weight in air should be reduced to the weight in vacuo, by adding to the weight in air the weight of the air displaced by the body, and subtracting from the sum of the weights used the weight of the air displaced by them.

The presence of the air may be neglected in all ordinary cases, as it would only affect the second place of decimals.

A substance like cork or paraffin should then be taken, and a sinker employed.

Suppose a body is acted upon chemically by water, some other liquid must be used. Thus a piece of sodium weighs, say, 10 grams in air, and 1 8 grams in naphtha, of specific gravity ·8. The weight of an equal bulk of naphtha is therefore 8·8 grams; but an equal bulk of water would be $\frac{8\cdot8\times10}{8}=11$. Hence the specific gravity of sodium would $\frac{10}{11}=\cdot9$.

Now take a specific-gravity bottle. It should be be quite clean and dry. It can be cleaned with a little acid, or if greasy, with a little soda. It can be sufficiently dried by warming it, and blowing into it, from a pair of bellows, a stream of air. Weigh the bottle; fill it with distilled water and weigh it again. The weight of the water can thus be obtained. Rinse the bottle out several times with alcohol, and then fill it with that liquid and weigh it again. The weight of the alcohol can then be found. The ratio of the weight of the water to that of the alcohol is the specific gravity of the latter.

With a specific-gravity bottle we are able to find the specific gravity of small fragments of substances. Suppose the weight of the bottle is 25·7 grams, and the weight of the water it contains at 4°C. is 64·85 grams Put 43·75 grams of shot in the bottle, and then fill it up with water. Suppose the weight of the bottle, shot, and water is 130·35 grams; which, less the weight of the bottle, is 104·65 grams. The loss of weight of the shot in water is obviously

$$64\cdot85+43\cdot75-104\cdot65=3\cdot95.$$

The specific gravity of the shot is

$$\therefore\frac{43\cdot75}{3\cdot95}=11\cdot29.$$

If the student has a Nicholson's Hydrometer, he can find with it the specific gravity of a liquid and a solid. The presence of air-bubbles will interfere with the accuracy of the results. These must be removed. Water recently boiled is the best to use. It will, of course, have occurred to the student that as a body loses, when weighed in water, the weight of an equal volume of water, this furnishes an easy method of finding the volume of bodies which are awkward to measure Thus we can ascertain the volume of an irregularly-shaped mineral, or a piece of copper-wire. Knowing the volume of the wire, and its length, its cross-section can be at once obtained by dividing the former by the latter. Its radius can be then deduced.

There is a very simple way of obtaining the specific gravity of liquids by weighing, say, a piece of glass in them and in water. The object is first weighed in air, then in water, and then in the liquid whose specific gravity is to be determined. If it weighs 34 grams in air, and 20 in water, and 10 in the liquid; the specific gravity of the liquid

$$=\frac{\text{loss of weight in liquid}}{\text{loss of weight in water}}=\frac{24}{14}=1\cdot7.$$

Further, if a glass tube, not too narrow, be bent into the shape of a U-tube, and water be poured into one limb, and oil or mercury into the other, when there is equilibrium the specific gravities will be in the inverse ratio to the heights of the fluids. This will be so, whether the tube be of uniform bore or not, a very important result, especially in relation to the method for obtaining the absolute coefficient of expansion of mercury.

(*To be continued.*)

—o—

Publications Reviewed.

PRIZE BOOKS.

MESSRS. BLACKIE AND SON'S LIST.

First Notice.

THE above publishers have sent in the following beautifully-bound, nicely-printed, and, in some respects, well-illustrated volumes.

They are all more adapted for boys than girls, being tales of adventure and heroic daring and enduring. Two of the parcel are fictions; two are collections of true stories; and the remaining volume is a combination of fact and fiction.

The teaching is rather moral than religious, but perfectly healthy and trustworthy. To treat them singly:—

(1) Robinson Crusoe.

We must not pass this work over by simply calling attention to it as another edition of this marvellous work, and remarking on the pictures by Gordon Browne, which are numerous and fairly reproduced, and the general appearance of the volume as attractive, etc., etc. Messrs. Blackie and Son have here reprinted the original work as it was issued to the English reading public in 1719. They assure us in their preface that 'no attempt has been made to polish the strong, unstudied diction of the author, or to improve on his homely, vigorous language.' True, they have very properly omitted some gross and profane expressions which were felt to be 'superfluous to the text,' and have corrected the spelling of a few geographical names, but, with these exceptions, we are assured we have the book as it was intended to be read by the author himself.

There is a short but interesting account of the first edition—of its success and how it gave rise to the second volume, or part, published under the title of 'The Farther Adventures of Robinson Crusoe, being the second and last part of his life, and strange, surprising accounts of his travels round three parts of the globe. Written by himself.' This introduction also tells us of a third part, called 'Serious Reflections by Robinson Crusoe,' which never became popular, as it had no real connection with the history of Crusoe.

There are some six pages devoted to the account of 'the man who wrote Robinson Crusoe,' which are well worth reading, as they tell us of De Foe, not only as a writer, but as a politician. No boy will be surprised to read that the author of Robinson Crusoe was a man of indomitable pluck, for who but such could conceive so wonderful a chain of events, in which pluck carried all before it?

We are distinctly warned that we must not expect to be able to parse according to modern theories all the sentences we find in the mouths of the characters who speak in the course of the narrative; and this, we are assured, is owing partly to the fact that the rules of grammar have somewhat changed, but more from the fact that De Foe was too good a story-teller to make an uneducated person talk too well.

(2) The Pirate Island. By Harry Collingwood.

This is not by any means Mr. Collingwood's first story for boys; we expected, therefore, a treat, and, let us say at the very outset, we got it.

The first two-fifths of the book or so are very like the majority of these boy books, which tell us of the sea and sailors. We have no less than three shipwrecks, told with a certain amount of detail, and a fourth referred to. On board the ship, to whose loss reference is made, there was found a baby, the sole survivor, well dressed in

linen all duly marked. This lad is brought up by a fisherman, and figures conspicuously in the first of the three shipwrecks. This brings him under the notice of the captain, who, eventually, takes him to sea; but before he sails with this new friend he takes a few trips on a collier, of which he sees the last, as he and the rest of the crew only just save themselves before she founders.

His first voyage to Australia, as an apprentice, is very successful and uneventful. From Australia they bring one of those extraordinary men, of whom, no doubt, there are examples, who can pretty well do everything. Though a military engineer by profession, he had planned and had constructed for himself a wonderful yacht which could perform marvels; in addition to this we find he has sufficient surgical skill not only to set, but even to amputate limbs. He, though not so called, is the real hero of the story, and being, withal, a very modest, self-contained man, is a charming companion, and one of whom we do not tire.

On their homeward voyage, the ship is discovered to be on fire, and, eventually, has to be abandoned. The captain, his wife, and little daughter, two lady passengers, three other passengers, and the apprentices, including the foundling of the wreck, are in the only boat which is saved: they are picked up by a pirate, and eventually landed on the Pirate Island, where they are made to work. Up to this point the story has kept along well-known and often-used lines, but here we have what may be called a new departure. We naturally then read this part of the book with more interest and curiosity. The wonderful passenger now begins to utilise his exceptional knowledge and powers. He builds a schooner, raises a fort, discovers mineral treasures, and acts as doctor. Of course, the excitement of the story consists in the solving of the question as to how they are to get away from their bondage. We are not going to tell how they effected this, beyond the fact that the denouement is brought about by our apprentice lad. On their arrival in England this lad's parentage is fully established, and all ends happily. We are promised at the end an account of the expedition (should it come off) which is being organised, to secure the mineral wealth of the island.

(3) Stories of the Sea in Former Days.

We are not told who the editor or compiler of these stories is. They are described on the title-page as 'narratives of wreck and rescue,' and we are assured that they are the accounts of actual facts 'compiled from authentic sources.'

There are no less than nine of them placed in chronological order, beginning with the adventures of Pietro Quirini, a Venetian (1431), and ending with the loss of the *Nautilus*, (1807). That boys love dearly to read *true* stories, no one can doubt, and—we all are far more lastingly moved by the account of a fact, however badly told, than by a fiction, however graphic; still we cannot help thinking that the editor or compiler might have done a little more than he has done, in preparing these histories for the press.

The stories are generally told in the form of narratives, by one or more of the actors in the scenes described. Sometimes these accounts do not quite agree, and we are left to form our own opinion. Now this may be all very well for men, but boys want things told them very plainly and in a matter-of-fact way. That wonderful history, the 'Mutiny of the Bounty,' which its sequel on Pitcairn's Island has made so familiar to the English-reading public, is here by no means particularly interesting.

No doubt, Christian's conduct was unjustifiable, though Lieutenant Bligh's was as aggravating as it could be, yet boys don't care to read counter-statements; what they want is to be able grasp the facts as they occurred: the lessons to be learnt from them will come by-and-bye. The fearful tale of the sea the newspapers have been lately unfolding to us may, perhaps, convince some, of the possibility of all that is told us here, of which, without such immediate corroboration, they might have been sceptical.

(4) Adventures in Field, Flood, and Forest.

Here, also, we have no editor's name mentioned, but are again assured that these stories of 'danger and daring are wholly founded on the real experiences of those who figure in them.' Though published before, the editor believes that the books whence they are taken are so out of the reach of general readers that the collection is practically almost a new one.

There are no less than twenty-one of these sketches. The second and third are entitled, 'The True Story of Alexander Selkirk' and 'The French Robinson Crusoe.' We have stories in New Zealand, Australia, amid the ice off Newfoundland, and the last but one is entitled, 'How an Irish Sailor became King in New Guinea.' The account how Sabinade Steinbach completed the Cathedral of Strasburg is perhaps, the best.

(5) Brothers in Arms. A Story of the Crusades. By F. Bayford Harrison.

Here we have a combination of fact and fiction. Amidst all the historical personages of the Third Crusade, two lads are introduced. They follow the fortunes of the lion-hearted king, and get mixed up in a very interesting way with the vicissitudes of the expedition.

That boys in this way read and learn a vast amount of history, no one can doubt. In these high-pressure days the tendency is to compress history into the barest string of events and dates. Such stories as these may add a little flesh to the dry bones of fact, so as to make the task a little less unwelcome.

The lads introduced here are interesting and courageous, and such as to excite the admiration of youthful readers, and there is evidently a denouement to be told at the end of the book which keeps the attention on the alert throughout.

Second Notice.

THIS second parcel, though equally attractive in appearance to those already noticed, is one of a very different class of books.

With one exception, these are stories in which many historical personages figure, and might be termed historical story books.

(1) The Wreck of the Nancy Bell; or, Cast Away on Kerguelen Land. By John C. Hutcheson.

This is the one exception to which reference has been made, being a story of shipwreck, etc., in which the characters and events are the creations of the author's brain. It is a book after a boy's heart, in which adventure follows adventure, as fast almost as one can turn over the leaves. Well-nigh everything that can happen to a ship on her way from the north to the south, does happen. They witness a fatal fight between a whale and a thresher; they pick up a small boat with several dead bodies and one just alive; they experience all the horrors of a cyclone; they endure an agony of suspense by discovering a fire in the hold; and so on, until the wreck comes.

The ship being a passenger ship, we have, amongst others, an old lady to afford amusement; a young one to sympathise with, in her love affairs; an imp of a boy to follow in his mischief; and a too-Yankee Yankee.

The captain is genial—well backed up by an intensely Irish first mate; and, as a barque of this kind would be altogether wanting if there were no coloured man on board, here we find him; but we must, at any rate, congratulate Mr. Hutcheson on the sable gentleman's manner of entrance on the scene.

We can promise any boy, lucky enough to get hold of this work, a great treat, and heartily recommend it to all prize-givers.

(2) Traitor or Patriot? A Tale of the Rye House Plot. By Mary C. Rowsell.

The hero of this pretty story is a young yeoman, living close to the celebrated Rye House. He is in love with

the pretty daughter of the old miller who was its occupant, and through her gets to know of the secrets of the traitors. At first, however, we find him to a certain extent implicated in the conspiracy—hence the title. A charming subterranean passage, so dear to a boy's heart, exists between the Rye House and the hero's home, which is utilised in the course of events.

The tone of the book is healthy, and the style graphic; and we wish it all success.

(3) **True to the Old Flag.** A Tale of the American War of Independence. By G. A. Henty.

Mr. Henty evidently feels his mission is to teach lads history, under the guise of fiction. We have no less than three of his efforts in this line before us, and the title-pages tell us of others he has given to the world previously.

He assures us in his preface, that justice has not been done to the bravery of the English, in that lamentable war which she so unrighteously waged with her N. American Colonies some hundred years ago. We were worsted, as we were bound to be, and we therefore keep silence in the matter. The Colonists were victorious, and they tell their story from their point of view; and who, under these circumstances, can be astonished that the English are not represented as being all that they might have been, and, in fact, in many instances, all that they were?

In reading history nothing is more important than to know by whom and for whom the history was written, if we would rightly judge of the authenticity of the facts and the correctness of the opinions to be gathered.

If English boys learnt their histories of Mary and Elizabeth from accounts written by Roman Catholics for Roman Catholics, would they have the opinions they now have of these two queens? Have not boys now a very different notion from what boys a hundred years ago had of the respective characters of Charles I. and Cromwell since historians have dared to examine facts with clearer glasses? Mr. Henty here shows us that, though the English arms were repulsed, yet there was no less bravery and loyalty than in those campaigns where all was success and honour.

The first few pages of the book are devoted to a description of what the backwoods settlers had to contend with in the raids of the Indians, after which we follow a lad, who, though born in the country, had volunteered on the king's side, together with his father (a retired English officer), from Lexington and Bunker's Hill to the surrender of Cornwallis.

Mr. Henty has taken great care in collecting his facts not to mislead, and intersperses his narrative with trite criticisms on the accounts given by the other side. A boy would have a very fair knowledge of the history of this important struggle if he could pass an examination in the volume before us.

(4) **St. George for England**: A Tale of Cressy and Poictiers. By G. A. Henty.

The same author here would waft his many boy-readers back some four centuries to learn of Cressy and Poictiers and the many brave doings of the Black Prince. The hero of the story, who appears as a prominent figure in the stirring events, is brought to London as a child by his mother, and, on her death, left in the hands of her old nurse and her husband, who bring him up as their son. He is apprenticed to an armourer, who teaches him not only how to make arms, but to use them. As a lad he had been noticed by the Black Prince, then a child of ten, and later on, the king himself, when present at the city sports, says a few kind words to him, when he receives the first prize for fencing.

An accident enables him to prevent the successful carrying out of a wicked plot to run down a boat on the Thames, and thus kill a good lady and her young daughter.

The author of this plot is the villain of the book, who never ceases to persecute our hero, until at last, after being outlawed and disgraced, he is slain in open conflict, when serving with the enemy. The history is carefully given, and the character of the Black Prince faithfully pourtrayed.

In conclusion, we do not know where we have met with a more fascinating story, nor with so successful an effort to combine history with fiction.

(5) **In Freedom's Cause**: A Story of Wallace and Bruce. By G. A. Henty.

Here Mr. Henty, with the same power which he has shown in the other works we have referred to, has gone into still remoter times, and tells his readers of how Scotland freed herself from the domination of England. In his preface the author acknowledges the labours of Mr. W. Burns in his work, 'The Scottish War of Independence,' as the source of his historical facts. As in 'St. George for England,' the events which preceded and led up to those in which the hero figures are carefully narrated to him by one of the characters, so as to enable the reader, if he forgets his history, to understand what is happening.

In conclusion, we cannot but think that others than lads are much indebted to Mr. Henty for these admirable tales, and we wish them all success, feeling sure that they will render very pleasant what is only too often considered a disagreeable task.

MESSRS. HODDER AND STOUGHTON'S PUBLICATIONS.

Second List.

(1) **The Story of the Life of Jesus.** Told in Words Easy to Read and Understand. By the author of 'The Story of the Bible.'

The author here has set herself no easy task, viz., to change the words of the narrative of our Lord's life from what we have in the Bible.

Bible language is so simple that we doubt if children can understand any modification of it one whit the better. We know of no life of Christ that does not send us back to the Biblical narrative unsatisfied and disappointed. It may be something to have the four stories welded into one, but even little children in hearing an account of a story they know from a second evangelist, are pleased to note where the accounts agree, and where they differ, as every infant schoolmistress could vouch for.

The story, too, is constantly interrupted by such efforts to teach as we find in the following extract.

In the chapter on the temptation in the wilderness we read:—

'Whenever Satan is going to tempt any person to do wrong he finds out what thing it is that person wants most. Then he tries to make him do wrong to get that thing. He knew that Jesus had fasted and wanted food, and he thought he would make Him do wrong to get it.'

There are forty full-page illustrations, in which the face of Jesus is the most unconventional one we ever saw. The landscapes are far better than the figure pictures, the latter being anything but good. The one that represents Jesus before Pilate is exactly that of a man with his hands behind his back, examining carefully a marble statue of a sitting figure.

(2) **The Children's Portion.** By Alexander Macleod, D.D.

The author tells us that this title ought to be filled out into the 'Children's Portion in the Sunday Service,' being, in fact, the short sermons addressed to the children on Sunday mornings. Their language is simplicity itself, and the manner affectionate. They would be very suitable for Sunday evening reading to children, when unable to go out to a place of worship.

(3) **There's a Friend for Little Children.** A Story. By Jessie F. Armstrong.

This is a very pretty little story told by one who loves children, and wishes to make them good.

There is a child-loving clergyman, and a good wife of a gamekeeper, who teach admirable lessons.

The pictures are charming, being drawn in outline. This would be an admirable prize for a little child who has just learnt to read.

(4, 5) **Scarlet Anemones, and The Two Sisters.** By L. T. Meade.

These are two little tales. The former is more suited for young children—the moral being the harm of deceit and the misery it brings with it. The latter deals with older people, and is more adapted for bigger girls. The lesson to be learnt is the beauty of self sacrifice, which here we find duly rewarded. The authoress' word-painting of scenery is admirable, as well as her development of character. As prizes we fear they are too small for the class of children to whom they should be given.

Plant Life. By Edward Step. London: T. Fisher Unwin.

That this little volume has reached already its third edition is more disappointing than encouraging to the lover of accurate science. The only encouragement to be derived from the fact is in the knowledge that there is a reading public anxious to be told in popular language truths about nature. But accuracy must not be sacrificed to popularity. Inspired by this sentiment, let us at once say that, despite the reaching of a third edition, Mr. Step's book is a very bad one.

Dedicated to the officers and members of the Lambeth Field Club, 'Plant Life' is a witness to the good and to the danger of these Natural History Clubs. It bears testimony to the love of Nature, the increased facilities for and power of observing natural phenomena, the wider knowledge, that these organisations foster. But it also warns us of the tendency to slipshod science, loose-thinking, inaccurate expression, that so frequently results when the little knowledge that is proverbially 'a dangerous thing' has been acquired

Fourteen chapters and 156 illustrations are devoted to the account of certain plants and certain special phenomena of the vegetable world. Of system there is none whatever, and in his appendix Mr. Step gives as his reason 'not only for want of system, but actually for violations in his grouping of the systematic arrangements in common use) this—that he is writing for the non-scientific student! It is when we are writing for the non-scientific student that, without any undue forcing on his notice of classification terms, he should by reading of plants or animals in their natural—*i.e.*, phylogenetic—sequence, learn unconsciously classification itself

One minor consequence of this unsystematic treatment of the subject is that we find Mr. Step occasionally repeating either one of the many authors quoted by him (pp. 123, 162), which is bad, or repeating himself (pp. 122, 158), which is worse.

Before dealing with the serious errors of the book, let us say a word or two as to Mr. Step's style. That is fairly clear. One can follow, as a rule, his statements This makes it the more matter for regret that the statements are so frequently inaccurate. Our author is also, we should think, a bit of a humorist in the family circle. The insects, *e.g.*, drowned in the pitchers at the base of the leaves of the Tree-pines are 'overtaken in their cups.' The epiphytic orchids are 'without any visible means of subsistence.' Fainter gleams of the same rollicking fun are to be seen when the insects are spoken of as persisting in committing suicide, and its last outburst occurs on p. 202, seven pages from the end The subject is the egg-cases of the dog-fish, commonly known as mermaids' purses. Mr. Step *loquitur*. 'We do not believe they are possessed of pockets wherein to keep them if they had them' The humour here is somewhat obscured by the vague use of personal pronouns to which the writer is given; but there is enough of it to show us the nature of the elephantine fun and banter with which we do not doubt Mr. Step is wont to set the Lambeth Field Club 'on a roar.'

Another peculiarity of style, and one for which we may be grateful, is the author's habit of making multitudinous and lengthy quotations. The book is as full of these as the play of 'Hamlet' was, according to the gentleman who saw it for the first time. In the quotations he displays a large-minded nature. Charles Darwin and the *Daily News, e.g.*, are laid under contribution, and the metrical quotations range from the poetry of Shelley to the verse of Mrs. Hemans. The worst effect of these almost innumerable extracts from the writings of others is that, like jewels in a common setting, they show up the want of finish in their surroundings.

As to the matter of the book, we may at once say that, but for the many mistakes in its science 'Plant Life' would be a useful volume for the lonely microscopist, far away from books of reference and from more skilled friends. It will be a help in identifying certain less-known plants, either under the microscope or in the fields. Further, some of the practical hints are excellent The construction of a fernery out of very simple and inexpensive materials, the advice to fern-collectors (p. 166), and that to the searchers after Fungi (p. 196) are of this kind The fact that Mr. Step gives due attention to the Cryptogams must be noted and commended The account of predatory plants that are not as familiar to the ordinary reader as the sundew or the fly-trap is another instance of good work.

Again Mr. Step has read widely, as far as the selection of authors is concerned. Thus Darwin is frequently quoted, though it is to be regretted that, in the reference to his works on the movements of plants on p. 6, only the early work, 'The Movements and Habits of Climbing Plants,' is mentioned Nothing is said of the later—and as far as botany is concerned the last—work of the master, 'The Power of Movement in Plants.' This was published in 1880; the book under review is already, as we have said, in its third edition. Culpeper has also been well studied by Mr. Step, and we are charmed to see, from p. 106, that he has read delightful Thoreau.

But with this, commendation must end Whether we consider Mr. Step's English, or his chemistry, or his physics, or his botany, the verdict has to be 'bad.' English first. He begins early. On p. 7 we have: 'This is the *Volvox globator*, a species that once puzzled scientific men considerably to assign the department of Nature to which it belonged.' Fourteen pages later occurs the following: 'But besides these zoospores and simple spores, the potato fungus produces a third kind called 'Oospores' which *were* unknown until Mr. Smith's careful study of the fungus by night and day, through its various changes and developments, revealed *its* existence. On p. 31, 'albuminoids, of which protoplasm itself is formed, and is dependent upon for growth and increase.' On p. 100, 'This case is botanically termed a sporange, and the clusters of them are spoken of as a sorus.' But the pronoun 'it,' is Mr. Step's chief stumbling block. It trips him up again and again. Here he has the attack in a comparatively mild form. 'The chlorophyll—bearing cells have the power of retaining the carbon, and setting the oxygen free; but *it* can only do so when under the influence of sunshine.' Here is a more virulent case: 'The protoplasm of the cells is thickly dotted with grains of starch, *it* being laid up in the tuber to provide nourishment for the new shoots (eyes). In the wheat, oat. rice, pea, and bean we find *it* stored up in the seeds, for the nourishment of the young plant or embryo whilst *it* is developing *its* roots and leaves.'

We are not quite sure, whether Mr. Step is a genuine believer in the doctrine of evolution, though we have *our*

suspicions. Whether he is or not, one passage at least in his book is illustrative of the doctrine. Everyone knows that the evolutionist is always on the look-out for transition forms. 'Plant Life' presents a very interesting case of gradation between bad English and bad botany (p. 35): 'If both are found on the same plant, they are monæcious.' 'Both,' it may be said, has reference to stamen and carpel flowers; but 'they' has reference, not to the stamen and carpel flowers, but to the plant as a whole on which they occur. Here is a sentence, therefore, that might be given to an examinee in English for correction, and that even taken at its best—and bad is the best—contains a blunder in botany.

Nor is the badness of the construction atoned by excellence of idea. It is true that on one occasion Mr. Step tries to be artistic, and only succeeds in being high-flown. Take his ambitious attempt at description of ferns and their habits and habitats, on pp. 95 to 98. It has periodical descents into baths, marked by such words as 'sifted,' 'wriggled,' 'percolating,' and by the injunction to carry the ferns home 'tenderly by the roots.' Or notice again, on p. 116, Mr. Step's benigning of the fairies, if we may coin a word. Everybody but Mr. Step knows that the fairies are called 'the good people,' for propitiation's sake, and not because the country folk think them really good. This method of naming is the same as that used by the Greek when he called the Furies 'Eumenides' (*ευμενης*=gracious), and by the Latin when he called the Fates *Parcæ* (*parco=I spare*). Yet the author of 'Plant Life' talks of the fairies as 'always performing good deeds.' This is what we call benigning them—a process better than maligning, but not so good as the truth. The fact is that Mr. Step knows no more of the fairies than of botany or of Latin.

Of this latter language we should hardly judge the member of the Lambeth Field Club to be a master, or even a scholar. He speaks (p. 110) of the 'stipules' of the ferns, not knowing that the plural of '*stipes*' is '*stipites*,' and on p. 158 he gives a quotation from Culpeper that is certainly bad Latin: '*E cenum Mars solus habet.*' We should think the blunder is that of the transcriber, rather than the old enemy of the College of Physicians. We may be unjust to Mr. Step in our estimate of his Latin knowledge. But when the only two classical words or phrases he uses are inaccurate, we are entitled to give him the benefit of our doubt. As he himself might have written, *Ex unum disce omnes.*

From language blunders let us turn to scientific blunders. Some of Mr. Step's sins are mere matters of carelessness; others are of a more serious nature. Of the former kind is the calling the Algæ a tribe, and the Fungi a family, and this within the limits of a single paragraph. The blunder is twofold. For, in the first place, neither of these groups is either a tribe or a family, and in the second, whatever the one is, that the other is; that is to say, the group fungi and the group algæ are of similar significance. Never were there two groups in all our many artificial systems of classification so parallel one to the other as the fungi and algæ; and to name them with different names, as 'tribe' and 'family,' is to betray an ignorance of botany that is scarcely in harmony with book-writing.

Other examples of carelessness are 'protoplasm covered with chlorophyl,' the statements that wood consists of cellulose (as if the substance of the original cell-wall underwent no change in becoming wood); that Mucor is unicellular (we know that Huxley and Martin are responsible for this error, that has been copied by every embryonic biologist since); that stomata are breathing-pores (made on p. 19, contradicted on p. 28); that flowers have stamens and pistils (the parallelism is between stamen and carpel, or andræcium and pistil); that fovilla is protoplasm (without any mention of its starch and oil); that the pollinia of orchids alter their position, after removal from the flower because of their weight and the slenderness of their stalks (no mention being made of the contraction of the membranous piece of the rostellum that is detached with them). Along with these instances of carelessness may be taken the absence of all attempt at giving the derivation of technical words; the utilisation of English measurements, and not of the decimal system; and the constant use of the dangerous phrases 'in order to,' 'for the purpose of.' The careful biologist is especially careful not to commit himself or Nature by expressions of this kind. He is content only to record facts.

But Mr. Step is far worse than a merely careless writer. He is an inaccurate writer. As we have said, his chemistry, physics, and botany are alike at fault. When, 'quite early in the volume,' we found him talking about carbonic *anhydride*, a dread fell upon us. The gloom of it deepened when the old artificial distinction between the organic and the inorganic was directly after insisted upon. Let us, as Mr. Step suggests, turn to a very clever chemist, and ask him what he thinks of the distinction mentioned above, and evidently credited by the author of 'Plant Life.' We turn to Professor Schorlemmer, one of the first of European chemists: 'To-day we know that the same chemical laws rule animate and inanimate Nature, and that any definite compound produced in the former can be prepared by synthesis as soon as its chemical constitution has been made out.'

The gross ignorance (we fear we can use no other adjective) of chemistry that is the unhappy possession of Mr. Step will be gathered from the following instances. Salts are said to contain potash; the carbon of carbon dioxide 'mixes' with the liquid food of the plant; nitrogen and sulphur are taken up by the roots (all these blunders are on one page—p. 30); potash and magnesia are stored up in the cells (p. 32); binoxalate of potash is mentioned; Protococcus is said to absorb carbon. Nor is this last tremendous statement a slip, as we might at first imagine. It is repeated on pp. 32, 124, 180. The passage on p. 124 is too delicious not to be quoted: 'The plants consume the poisonous carbon with which the respiration of animals has polluted the air.'

Mr. Step is as bad a physicist as chemist. He gives, as one of the conditions necessary for the growth of plants, '*heat* above the freezing point.' The italics are ours, and ought to be followed by a note of astonishment. Of course Mr. Step means 'a temperature' to be read for the word 'heat.' But that he is densely ignorant of the difference between heat and temperature let the very next sentence bear witness: 'The quantity or degree required varies with,' etc. Here we have the completest proof that the writer does not know the difference between quantity of heat and degree of temperature. Again a like proof is forthcoming on p 151 (the foregoing was culled from the prolific page 32): lichens, we are told 'can endure a greater amount of cold than any other plants.' One would have thought that the presumption of a man pretending to teach science, when he can seriously write of 'a greater amount of cold,' would have been evident to that stereotyped observer, 'the meanest capacity,' if we did not see that it is not evident to Mr. Step.

Frankly, we are weary of exposing the incompetence of this author Patience fails us, and we can only very hurriedly, in conclusion, mention a few cases in which the botanical blunders are more than careless—they are inexcusable.

A cell is, with Mr Step, only the wall, not the protoplasm included by the wall. He talks quite gravely of 'true species,' as if such entities existed. And he has impertinence enough to laugh at the hypothesis of Schwendener as to the nature of lichens. The reader will scarcely credit this after the criticisms that we have been forced to make. Nevertheless, incredible as it may appear, this amateur dares to talk of Schwendener's hypothesis that lichens are fungi Parasitic on Algæ as 'a humorous theory' (p. 149) that has 'met with the ridicule it deserved.' This is the theory of which Sachs, the foremost of German botanists, in the translation of his second edition by Vines, one of the foremost of English botanists speaks (without adverse criticism on the part of Vines) thus: 'The admirable labours of Schwendener have shown that lichens, hitherto considered as a separate class, must not

only be included among Fungi, but must be regarded as a section of a particular order of Fungi.' This is the theory Bornet has, by actual experiment, corroborated. A man who has been favourably criticised, or, indeed, has had his views endorsed by three such men as Bornet, Sachs, and Vines, can afford to smile at the ridicule of a Step. Perhaps, after all, the latter is indulging in the Lambeth Field Club vein.

The book is prettily enough printed and published. Only one thing is more marvellous than the temerity of publishing a work so full of errors—that is, that the ignorance of the writer did not prompt him to silence.

Our Schools and Colleges. Vol. I. Boys (Eighth Edition). Vol. II. Girls (First Edition). Being a Complete Compendium of Practical Information upon all Subjects connected with Education and Examination. By F. S. Dumaresq de Carteret-Bisson. London: Simpkin and Marshall.

These portly volumes of nearly 2,000 and 1,000 pages respectively, give a vast amount of information of all sorts and kinds in connection with places of learning. Beginning with the universities, they descend to small preparatory schools of only a few students. Of the colleges they give a complete account of the different methods of proceeding to a degree—with the expense thereof. We also have the expenses given in connection with the different schools.

There is an alphabetical list, at the end of the books, of all whose names are mentioned in them, with a reference as to the page, so that the volumes become, to a certain extent, a schoolmasters' and schoolmistresses' list.

School inspectors, and all connected with the Education Department in Whitehall, also figure here.

Oxford and Cambridge local examinations are fully explained, and a list of the local secretaries, from whom information may be received, given.

The music and art schools are also described, with more or less inserted as to fees, etc.—according, we presume, to the amount given by their respective officers.

To one wanting information as to how to study any art, or where he may place his boys and girls at school, the volumes would prove very useful. Every edition, no doubt, will be an improvement on its predecessor. For specialists, with their whereabouts and fees, a place might be found, as well as for professional teachers, who happen to be unemployed at the issue of the edition, and private tutors.

Longmans' Magazine. London: Longmans and Co.

This monthly continues to merit a large share of public patronage. The Christmas number is now before us; its contents are varied, interesting, and attractive. Though some of the contributions are hardly in keeping with this festive season, an excellent shilling's worth of literature is provided. A skit on the Psychological Society by F. Blind, 'Two Robbers,' by the author of 'Reata,' and Wilkie Collins' 'Royal Love' are alike excellent. The illustrations, which are printed in colours, have been done by some of the most popular artists of the day, among whom are Du Maurier, J. Pettie, Marcus Stone, Walter Crane, and Birket Foster.

Cornhill Magazine. London: Smith, Elder and Co.

The most attractive feature of the November issue of this popular magazine is, without doubt, the vigorous and graphic sketch, entitled, 'A Female Nihilist,' by Stepniak. This article alone ought to command an extensive sale for *Cornhill.* It is not often one has the chance of reading so vivid and life-like a story, even in the realm of fiction. Mr. Payn, the editor, and other favourites also contribute to this number.

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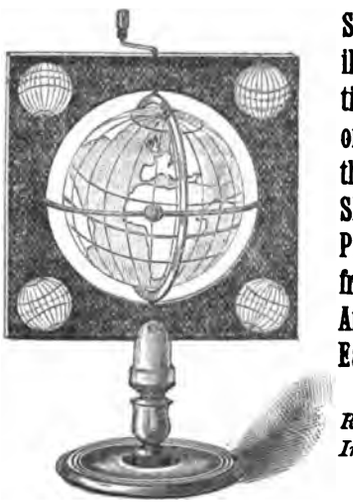

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Chairman of the Council of the Sanitary Institute.

THE SCAVENGING OF TOWNS—(*continued*).

Dustbins are abominations which should be discouraged as much as possible; the law allows, nay, even insists upon, their being provided. They are necessary evils which our social customs will not allow us to do without. They should only receive dry dust from the fireplace, and on no account should moist articles, such as fish-bones, skins of animals, putrid game, or offal, be thrown into them. They should be placed at a distance from the wall of the dwelling-house, or if people are compelled to use the outside wall of their building, then the latter should be cemented, and rendered waterproof, unless an impervious receptacle is used. Vegetable refuse should always be burnt in the kitchen fire. Animal refuse and bones should not be stored near to or in the house, under any pretence whatever. They are generally thrown into the dustbin for convenience. The bin should be of galvanised iron, as being preferable to wood; it takes up less room than brick, and can be kept quite clean. It should be covered to keep out the rain. Bricks are pervious, and retain putrid germs. The local authority should make arrangement for the bins to be emptied twice a week in hot weather, and once a week in the winter-time.

In most places the cooks will throw objectionable matters into the dustbin, and we have to deal with customs as they are. It would be much better if a moveable pan could be daily emptied. Those who have gardens would do well to keep the dustbin as far away from the house as possible, and instruct the gardener to utilise the refuse in ways which he will know how to make beneficial in his work.

The custom of piling up immense heaps of house refuse, which local authorities indulge in, which contain all the abominations belonging to town dustbins, and which is done in order that the heap may ferment and the animal matter may decompose by putrefaction, is highly injurious. It is also the custom for town councils, etc., to dispose of this refuse to brickmakers. The latter sift the refuse, separating the small pieces of cinder, coal, wood, and other combustible material from the dust. The sifted particles which are separated are called *breeze*, and are preserved to enable the brickmaker to burn his clamp of bricks, by spreading them into layers between the dried brick-shapes. Other materials picked out from the sifting are called *hard* and *soft core*. The ashes are mixed with road-scrapings, and any other sandy or muddy matter which may be at hand. The soft mud is then moulded into brick-shapes, and dried. The clamps are built with layers of breeze, between the layers of moulded bricks, and they are then coated over with a covering of old bricks and mud. The clamp is then lighted, and the most pestiferous odours pervade the neighbourhood until the burning is completed. The bricks thus produced are, probably, about as abominable as it is possible for such things to be. They are guileless of clay. The burning has been scarcely sufficient to drive off all the ammoniacal matters which they did contain; they are excessively absorbent of water, and will take up an immense quantity of rain in wet weather, so that the house will always be damp. They also contain potass salts, which are seen in dry weather to effloresce on the surface of the bricks, and in a few years they will crumble into the dust from which they have been manufactured. It is far better that the refuse from dustbins should be thrown on to a furnace and utterly destroyed, than that it should be utilised for brickmaking. The collection of house refuse should always be made by the local authority, and never given over into a contractor's hands. The object should not be to make money or to save a few pounds in annual expense, but to keep the kitchen and back premises clean and free from nuisance of any kind. A contractor will do that which pays best, and leave the others undone. Breeze ought not to be permitted, unless it is sifted out at once, as soon as the dust is collected. The 'hard core,' as the clinkers, stone bottles, and similar things are called, may be used in road-making; and the 'soft core,' or manurial part of scavenging, should be removed into the country day by day, so that no putrefaction should be allowed to take place until this part is in contact with the earth, to which it should always go as useful manure.

It used to be the custom for most owners to take out the gravel, sand, or clay, or stone (which made up the ordinary foundation of a town) in a building plot, and then stick up a notice that—'*Dry rubbish may be shot here.*' By this means, the hole was filled up again with every kind of abomination without expense to the owner, who then proceeded to build upon the place thus filled up. A house constructed over such a deposit must of necessity be unhealthy; and the custom has caused the deaths of hundreds of innocent people. It is now, however, nearly obsolete; but inspectors and surveyors require to keep their eyes open to prevent the custom being resorted to in bye-ways by unscrupulous landlords. 'Destructors,' 'carbonisers,' and other machines have been patented for dealing with house refuse. There is also a machine in use down the river Thames, which is called 'the devil' or carcase-crusher, which will reduce a dead horse to mincemeat in less than a minute. Large cities must have these machines, otherwise they will be unable to deal successfully with the immense mass of refuse, both animal and vegetable, which daily comes into their hands. It is right to turn these masses of matter to account, but I object to the fat which is collected at some of these depôts being sold to butter manufacturers and turned into 'butterine.' The fat which is collected at these places is only useful for those manufacturing purposes which are unconnected with food supplies, and ought to be so used up as not to make it possible for food dealers to get hold of it.

The Disposal of Slops.—If there is water-carriage for the disposal of excreta, the slops may go into the house drain with the excreta. By slops I mean the waste from baths, kitchen sinks, urinals, etc., exclusive of fæcal evacuations. Slops are said not to be sewage in the strict meaning of the term, but they are really as much sewage as the sewage from a water-closet. If there is a dry system of sewage disposal and no drains, it is the best form to have a flush-tank which is self-acting, such as that constructed by 'Rogers Field,' so that the slop water may be utilised, where a field is available for the purpose. If this cannot be done, then some kind of slop-pail must be used, and the slops emptied, when the pail is full, into some filter-bed. It is wrong to allow such things to go into surface-drains or ordinary water-courses, until they have been filtered. It is easy to arrange something of the kind in an ordinary garden in country places.

Cesspools should not be permitted unless they are constructed at a distance from habitations in a very porous soil, such as chalk, sand, or pervious stone, with intercepting-trap between the house and the cesspool, and the latter ventilated by a lofty pipe of small size, so as to allow of slow escape of foul gases, but not of free circulation of air, the ventilation being simply for the protection of the intercepting-trap. The cesspool should not be cemented and rendered impervious, unless there is risk of contaminating a neighbouring water supply. In this case it is necessary to have the cesspool pumped out very frequently and the sewage utilised at a distance from dwelling-houses by surface irrigation. It is an odious plan, only to be used when no other is possible. Stored sewage will putrefy and lose its true value as a manure, whilst the smell which may arise in its distribution is bad; and is sure to be complained of by the neighbours.

Surface Water.—'The rain to the river, the sewage to the soil' sums up in a very few words the essence of drainage. No place is properly provided with drainage if the surface water is abstracted from the ordinary water-courses and sent into the sewers. The ordinary water-course should, whenever possible, be kept open to the air. It is a mistake to put running water into drain-pipes except in draining agricultural land, but whilst running streams and occasional torrents should run in their ordinary channels in the open air, and be kept free from manifest pollution, thickly-peopled cities must allow the washings of their streets, of their courts, stable-yards, and pavements, to go direct into the sewer. The excreta of animals foul the surface. The first washing after a long period of fine weather is as truly sewage as any sewer can possibly contain. It may be necessary also to allow the rain-water pipes from the roofs of houses to discharge into these channels; but at the same time the advantages which rain-water affords for washing purposes should not be lost sight of, whilst those who keep animals, such as horses and cows, will do well to preserve it for their use. Domestic animals prefer rain-water to hard water for drinking purposes, even when the former is apparently unwholesome from soot and other contaminations, and it is the best for them. I always advise householders to store their rain-water, provided they can do it without making any part of their house or the basement thereof damp. If the rain-water pipes lose into the sewers, they may have intercepting-traps, though these are really useless in long-continued dry weather, and if the ordinary sewers are properly constructed so as not to contain deposit, traps are unnecessary. Unfortunately, very few sewers in any of our large towns are so perfectly constructed as to be free from deposit. If water-pipes are not trapped, care must be taken that the opening under the eaves of the roof shall be in such positions as to allow of the immediate diffusion of any sewer-gas which may pass up it, without that gas being able to find its way into any open window.

House Drains and Sewers.—I entered so fully into the proper construction of house drains in 'Health at School' that I will refer my readers to that volume for information upon these points, premising only that large sewers are objectionable, that six-inch drain-pipes well-jointed, laid with good fall are the best size for common use; they should always be laid upon concrete, unless the original or virgin foundation of the earth is very solid. They should never pass directly through the wall of the main building—that is, they should never pass under any house, but be cut off so that the house-drain may communicate indirectly only, the disconnecting manhole being capable of easy examination. No deposit should ever be allowed to take place in any part of its course. The soil-pipe of the w.c. should always be outside the house, so that the sewer with which it is connected need not pass through the walls. Drain-pipes should always be round; the glazed ware are excellent for the purpose with asphate joints, smoothed off very carefully inside, so as to prevent impediment to the passage of sewage, and each joint should be concreted on the outside. Lead or iron may be used, and in certain positions it may be advisable to use such, but all kinds of drain-pipes should be tested by hydraulic pressure before they are used, so that they may be really impervious to the passage of sewage or sewer air from within outwards, or to the entrance of ground water from

the outside. Four-inch drains may be allowed if all these conditions are complied with, and then four-inch pipes are even better than six inch, but no single house will ever require a larger bore than six inches. As to fall, one in fifty for a four-inch drain, one in sixty for a six-inch, and one in eighty for a nine-inch, will be sufficient, and ensure freedom from deposit if all the connections are correctly made. When surface water enters a sewer or house-drain there should always be a trapped gully over a disconnecting manhole, so that small gravel and other materials may fall to the bottom and be retained and not pass into the sewer. This manhole should have a syphon-trap between it and the sewer, the communication with the latter being at a higher level than the delivery-pipe. The trap should be frequently cleared out and disinfected by being washed out with chlorine water or solution of chloride of lime, if there is any evidence of decomposition in the manhole. It is also important that house-drains should be placed so that they can be easily examined. Every house ought to be provided with a map or plan showing the position of the house-drain, and the point at which it communicates with the public sewer. There should always be an easy means for examining this point. I have been accustomed to test the drains of a house by sending up them a spray of oil of peppermint or sulphur fumes, or even the smoke from burning brown paper. These odours find their way out at those points which allow of the exit of sewer-gases, and defects may be detected in this way.

Main Sewers.—This portion of our subject would require a volume for the purpose of dealing with it properly. It falls more to the province of the engineer than to the surveyor or inspector. I may, however, premise that no main sewer ought to allow of deposit of any kind within its cylinder, and that sewers that are too large are obnoxious, because they cannot be properly cleansed by the sewage itself, a coating of sewage always taking place in the bore of the pipe or culvert at or about the level of the flowing sewage.

(*To be continued.*)

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The Discipline of the Mind.

BY W. C. COUPLAND, M.A., B.SC.,

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VII.—The Formation of Habits and Character.—(*continued.*)

There are two classes of motives which must be relied on both here and there, the self-regarding and the extra-regarding, prudence and sympathy. The system of duty embraces both, for though neither *qua* feeling is moral, yet as directed to the end of universal well-being, they are both elevated to the rank of the moral motives proper. It is not true, I think, as is commonly supposed, that self-love is something more deep-seated and primordial in our nature than sympathy. On such an assumption is based the idea that we must be content in juvenile training to make the earliest appeal to self-interest, and reserve appeals to disinterestedness to a more advanced stage of rationality. On the contrary, the right training should endeavour from the first to establish an equipoise between the egoistic and altruistic impulses, for which a basis is given in the essential sociality of human nature. It might even be maintained that a keen eye for our own interests is a late development, at least in a large number of instances. The utter disregard of personal well-being, the generosity which oversteps rational bounds, are characteristic of an early period of life, and often as much need the trainer's care in the way of pruning as the feeling for others' good requires prompting. What is true, however, is that both self-love and love of others are at first awakened through vivid sensation and present emotion; and only gradually are called into activity through ideal suggestion. The child cannot be affected by what is remote, by influences which require a high pitch of imagination, or which entail a vast series of not very evident consequences. This is why a corrective discipline must operate by influences which can be immediately felt, by speedy gain and retribution. But none the less must such rewards and punishments be analogous to those which fall to the lot of the mature mind, if this discipline is to have a permanent value. In the life of the world the good and evil effects of conduct are often brought home very indirectly. Retribution is often long delayed, and the path to permanent success is wearisome to a degree. I take it that a true school-discipline should prepare the mind for this, by making the consequences of conduct more and more re-presentative, in conformity with the mental development. Certain and sure, however, the consequences should always be. The whole value of the moral education of the school is that it is a genuine economy, that it saves the wasteful experience of after life. The unreflective mind is apt to question the universality of the Law of Causation, and, long after it is convinced that Nature knows no exceptions, to believe that in the human social world reaping is not united by a necessary tie to sowing. It imagines that there are short cuts to affluence, that there are other ways than the path of duty to true glory, that it is possible to outstrip competitors by well-managed deception, and yet not suffer for it. And, owing to the limitation of human vision, it is undoubtedly true that lucky strokes of successful knavery are sometimes made. But then it is as at a public gaming-table. Lucky throws are possible; but the chances are heavily in favour of the 'bank.' Seeing the mischief that is often done by 'pious frauds,' it might be well to lay before the elder mind the true state of the case; to point out the divergence of the real in human life from the ideal; for veracity, like honesty, is in the long run the best policy. But, although no concealment in the matter is desirable, any harm that might conceivably flow from such a revelation should be easily neutralised by a formed habit, habit which has been engrained by the exceptionless play of cause and effect. The child should always *atone* for its misdeeds, should always reap the reward of its diligence and good behaviour. The breath of favour and disfavour must be immediately felt, and must be wafted with strict impartiality. As is sown so should be reaped. Nothing is so bewildering to a growing mind as a teacher's capriciousness, a deviation from a strict rule of justice. Teachers cannot be free from unforced partialities; lovable natures must exercise their subtle spell, and odious dispositions secretly repel; but in the pupil's presence all scholars must be equal, and like causes must be

followed by like effects, like good or evil deserts be attended by like rewards and punishments. As hinted above this is not strictly in accordance with the experience of mature life, but it is in accordance with the ideal of that life, and one aspect of civilisation is an approximation to such a state of things. The growth of knowledge and of the social feeling is attended with a lessening of caprice.

And so in school training, caprice must vanish—caprice in the apportioning of rewards and punishments, caprice in the kind of rewards and punishments. The former is self-evident; the latter has never been seen so clearly. The reason is plain. The true object of punishment is only gradually dawning upon the general mind. The pristine theory of punishment, which still survives, is that it is an infliction of pain, as penance for the infringement of rights or for contempt of authority, the requital of an affront to the sovereign majesty either of the civil government or the individual. The satisfaction of the feelings of the injured or insulted party is considered the end of the infliction; and, as we know, in rude ages these feelings were estimated according to the social rank of the injured individual, the penalty to be paid for insult to a king, or the crime of high treason, being indefinitely greater than that paid for a similar offence to a more lowly member of the community. This theory may now be pronounced obsolete (not so the practice founded upon it); and it is held that the only legitimate ground of punishment is the prevention of a repetition of the offence, and the only allowable description of punishment that which is reformatory of the criminal. Now, it is found by experience that punishment which has no relation to the offence—that plays the part of a sort of hopeless treadmill, like the aimless labour of the fabled Sisyphus—is simply pain-inflicting, and not reformatory; nay, its effect is frequently indurating, strengthening the evil disposition, and producing stoical indifference. The stock methods of the scholastic Rhadamanthus are flogging, and 'impositions,' or the interminable writing out or committing to memory of the pages of some arbitrarily-selected author, usually a fine classic—to such base uses is the fruit of the world's wisdom often put! As regards flogging, not a word is to be said in its favour. Sensitive natures are crushed by it; in coarser natures a spirit of defiance is aroused, and the embryonic conception of moral law thoroughly materialised. In neither case is there that fruit which is desired, a security for future better doing. The dreary imposition of tasks, which have no aim save that of exacting a pound of weary flesh, is probably doomed to even speedier abandonment.

But, although the folly of these rough-and-ready methods is coming to be seen, there is not always the perception of a truer course. It is not certain that the trainer will obtain a clear insight of this more excellent way. This, however, can be no other than that which is truly reformatory of the disposition which has been shown by the faulty conduct to be perverted. What is required is a readiness to act in a certain manner, a formed habit; and this is only to be brought about by associating the action with its natural consequences, not by so many slaps every time the delinquent is caught. The proper punishment for slothfulness or procrastination is a loss of valued opportunity; for theft restitution and loss of trust; for wanton aggression restraint of liberty; for leze majesty, or contempt of the constituted authorities, social outlawry,—the misery of loneliness through being shunned by the community. When the punishment is natural and not arbitrary the dangerous spirit of rebellion and defiance is cowed. The prophecy is then literally fulfilled that as we mete so is it measured to us; and the delinquent does not feel that he is under the heel of a powerful tyrant, at whose mercy he is, simply because he is weak; but the judge who pronounces the sentence is impersonal, and the decree is not murmured at, because it is felt to be entirely just.

It is by the discipline of the natural consequences of action that the true conscience is formed. My readers well know that in the philosophy of conduct no subject has been more debated than the nature of conscience; it being held to be now simple and primitive, now complex and derived, now progressive and uncertain, now immutable and clear. But it is still held by all parties that it is a universal and inalienable possession, and that it should possess a singular authority. It would be beside my present mark to dilate upon the subject; I will only observe that the universality of 'conscience' points to its being a formal rather than a material principle; that is to say, the actions with which it deals are indifferent to it. As, like the sovereign, it is above the law, it knows nothing of the strifes of parties and particular legislation. Whatever be the accepted moral code of the time and place, its verdict is always the same—*infringement of the law is wrong*, and is felt to be deserving of punishment, punishment which in memory becomes remorse. This being its nature, however, the immense importance of a worthy code can hardly be exaggerated. In the period of pupilage when ordinances are unwise, one of two evils results; either the reason of the pupil rises above the law, and the authority of the law-giver is impugned, or the moral sense is perverted. But these consequences are only too frequent in ordinary school legislation; it is well if the lesser of the two evils, the impugned authority of the law-maker, be the sole mischief.

The substance of morality must be strictly human. By that I mean that the worth of actions must be determined by the consequences to man himself. No other standard is free from all doubtful disputations, and beyond the canker of subtle disbelief. Personal and social well-being is the end and aim of all law, and to prescribe duties out of all relation to this end, or to frame a list of 'sins' which cannot be brought home to the natural sense, is to set about forming a character indeed, but a character which may as easily prove a curse as a blessing. The discipline of the mind, at any rate, finds its terminus here. Man, as a child of Nature, the latest birth of time, standing on the wrecks of ages, surveys the lower life from which he springs, and forecasts a future beyond his own little span; revelling, perchance, in dreams of worlds unlit by sun or star; but, however lofty his imagination, however penetrating his understanding, his rule of conduct can have no wider scope than the welfare of his peers, the beings to whom he owes all he knows, and whose joys and sorrows form the sunshine and shade of his inner life.

Article 106 (*b*).

Merit Grant in Infant Schools.

BY MRS. MORTIMER,

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Section II.—Phenomena of Nature.

LESSON—THE SUMMER.

CAN you tell me what part of the year we spoke about last week? Yes, the spring. How many months are there in the spring? What are their names? Can you tell me what comes after the spring? The summer. And how long is the summer? Can you tell me the names of the months? What kind of weather do we have? Yes, it is very hot, and we see the sun for a long time. What kind of days would you say we had? The days are very long, and the nights very short. Yes, when you wake up in the morning you see the sun shining, and when you go to sleep at night it is still light.

Are you glad when the summer comes? Yes, we can keep out of doors then. You are able to have all your games in the open air; and the bright weather makes you feel very happy. Your fathers and mothers are also very pleased to see the summer come. They are able to get out into the fresh air after they have finished their work. Can you tell me some of the things we do in the summer-time? Little children go for nice walks in the parks and fields, they run and jump about, and when they are tired they can sit down on the grass without catching cold. Could you do this in the winter-time? No, we have to go indoors when we want to sit down. What do the big boys do? They play at marbles and tops, and also at cricket. If they are near the water they like to bathe in it, for it is not very cold. Men also like to row the boats on the water, and sometimes boys sail their little ships. Then you can go fishing without catching cold. Yes, and there are many other things we do in the summer-time.

Although you can play so much in the open air you must be careful not to get too hot, nor to stand about in the sun without having your hat on, for you are sure to be very ill if you have your head uncovered.

There are other reasons why we like the summer to come. In the summer-time all the things in the gardens and fields grow very fast, and the fruit gets ripe. Can you tell me some of the fruits that grow in the fields and gardens? The apples, pears, plums, cherries. Yes, these all grow on trees. Tell me the names of some that grow on bushes? Yes, currants, gooseberries, raspberries, and strawberries. Well, the raspberries grow on what are called canes, and the strawberries grow on little plants close to the ground. Then we see the corn growing very high, and towards the end of the summer it gets quite ripe. We like to see the golden ears of corn with the sun shining upon them. Can you tell me the name of the corn of which flour is made? It is called wheat. What do we make of flour? It is made into bread. When we see the fields full of good wheat we know we shall have good bread. When the corn is ripe it is cut down, and we say the harvest-time has come. Haymaking should also be referred to.

Then the gardeners are very busy in the gardens. Why? Because the gardens are full of flowers, and they all want looking after. Can you tell me the names of some of the summer flowers? Roses, geraniums, fuschias, marigolds, nasturtiums, sunflowers, sweet peas, mignonette, etc. The warm weather makes these and all other things grow very quickly. Some things, however, which we do not like in the garden give the gardeners a great deal of work. Can you tell what they are? Yes, they are the weeds. Why do we not like them? Because they spoil the garden and prevent the flowers from growing nicely. The other day some little girls told me they had a nice lawn in their garden. What do we call a lawn? A nice plot of grass. Well, what does the gardener have to do to this? He has to cut it very often. Why? Because it grows so quickly in the warm weather.

In the summer-time you have nice long holidays. Where do some of you go then? To the seaside and into the country. The pleasures of the seaside and country should then be slightly alluded to.

Section III.—Scenes of Common Life.

LESSON—THE PARTS OF A HOUSE.

To-day, children, we are going to talk about the different parts of a house, and I want you to tell me the uses of them.

First tell me all the different parts you can think of. The walls, the windows, the doors, the roof, the rooms. That will do. Now, of what are the walls made? They are made of bricks, and sometimes of stone. Of what else are they sometimes made? How many of you have seen wooden houses? Well, then the walls are sometimes made of wood. A little boy says they are made of tin. I think he means of iron. I daresay you have all seen the church not very far from here that is made of iron. That is only put there until the people have enough money to build one of bricks or stone. Why do we build the walls of bricks or stone? To keep out the wet and the cold. Of what other use are the walls? They have to hold the floors, the windows and the doors. Where is the roof of the house? At the top. Of what is it made? Of slates or tiles. Yes, and in the country it is made of straw, etc. We say these kinds of roofs are 'thatched.' Are the roofs generally quite flat? Oh, no, they are slanting. Can you tell me why they are slanting? For the rain to run off. Where does the rain run to? The rain-water runs into the gutters. Where are the gutters? All round the edge of the roof. Yes, and I daresay you have all seen a long pipe running down the wall of the house from the top to the bottom; this pipe carries the water from the gutters into the drains. In the country the people have very large tubs, and the water from the pipe runs into them. This water is very soft and nice for washing. Why do not the people in London do the same? The teacher should briefly explain this to the children.

What do you see on or above the roof? The chimneys. For what are they used? They carry off the smoke from the fires. Where are the fires? Inside the rooms. For what do we use them? To cook our food and to warm ourselves.

When you want to get into the house, what must you do? Wait until the door is opened. When you have entered the house in what part are you? In the passage. Yes, sometimes we call it the hall. What can you see when you are standing in the hall? A number of doors. Where would they lead you? Into the rooms. What else do you see from the hall? The stairs. Where do the stairs lead? To the rooms on the next floor. What do we call the part at the top of the stairs? The landing. If you stand on the landing what do you see? Several doors. What do these open into? Into different rooms. What do you call the stairs leading from the hall to the landing? A flight of stairs. Is there more than one flight of stairs? Yes, there are generally two flights and sometimes more. Well, Mary says there is a flight of stairs in her house leading from the hall down to the kitchen. When you have to go downstairs from the hall to the kitchen, we say the kitchen is in the basement. What do we call the rooms on the first landing? The first floor. And on the second landing? The second floor. So you see in some houses we have a ground floor, a first floor, a second floor, etc.; and then in others we have a floor below the ground floor which we call the basement.

Why do we have doors to our houses and rooms? To keep out the cold and the wet. And for what else? To prevent anybody from walking in when they choose. What do we do when we go out? We lock our doors. Why? So that our house will be quite safe. If we

were to leave our doors open perhaps some persons, whom we should not like, might come in. Tell me what you call those persons? What do you mean by robbers and thieves? Yes, bad people who get into our houses and take our things away.

Then you told me there were windows in the house. Of what are they made? Of wood and glass. Of what use are they? They let in the light, and at the same time keep out the cold and wet. Why are they made to open and shut? When it is warm weather or when the room is too hot we are able to open the windows and let in the cool air, and when the room is cool enough we can shut them again.

Tell me the names of the different rooms in your house, Harry? The kitchen, the sitting-room, and the bed-room. Who can tell me the names of any other rooms? The scullery. Well, Willie? My uncle has a dining-room. Yes, and some people call another room, the parlour or drawing-room. The children might then be asked the use of each room.

Then we must not forget that your mothers like to find nice large cupboards in the different rooms. Why?

Summary.—The children might write on their slates the names of the different parts of the house, and for a further exercise they might say of what they are made, and for what they are used.

Section IV.—Common Employments.

LESSON—THE PORTER.

Now, children, I want you to think of a railway station, and tell me what you can see there. Yes, that is right. Now what men do you see about the station? The porters, the guards, the station-master. Where do you generally see the guard? In the train. How do you know a porter? By the dress he wears. What kind of clothes does he wear? They are of a dark colour, they look thick and strong. On his coat he has rather large buttons, and on his cap there are some letters. Tell me some of the letters you have seen? Harry says he has seen M.R. and D.R. Jack says he once saw G.N.R., and Mary said she saw S.W.R. Well, these letters show which railway the porters belong to. M.R. stands for Metropolitan Railway, D.R. stands for District Railway, and G.N.R. stands for Great Northern Railway. I wonder who can tell me for what S.W.R. stands? That is right, it means South Western Railway. What kind of coat does the porter wear? It is a short one, and it is called a jacket. Do the guards and ticket-collectors wear the same kind of clothes? No, they are made of smooth cloth, and they have long coats instead of jackets. One little boy says the porters wear striped jackets; well, they sometimes do in the warm weather, because their other clothes are so thick and warm.

I want you now to tell me some of the things you have seen the porters doing. They sweep the platforms, pick up the pieces of paper, clean the lamps, and when the weather is hot they sprinkle the platform with water. Why do they do this? To keep the stations cool. But the porters do something else. What do they do when the train comes in? They call out the name of the station very loudly. Why? So that the people in the train may know where they are. The porters also call out where the train is going. And what else? They open and shut the carriage-doors and help the people in and out. Then they have to look after the luggage and see that it is right. How can they tell? They read the papers on it. Yes, we call these papers the labels. If your luggage is too heavy for you, the porters will carry it for you.

You see, then, that the porter has a great many things to do and see to. What kind of man ought he to be? He ought to be quick and strong. Why? Because he has to carry heavy luggage, and the train cannot wait long for him. Then he should be kind and civil. Why? Because he has to help people and tell them where to go. Then he must be clean and able to read. Why? Because he has to look at the labels, and he has to label the luggage when you are starting.

Chemistry of the Non-Metallics.

BY EDWARD AVELING, D.SC. LONDON.

[This series of articles, whilst dealing with the subjects required by the University of London for the Matriculation Examination and with those required at the Elementary Stage of the Inorganic Chemistry (Branch X.) Science and Art Department, is intended as a practical guide to the philosophical and systematic study of the non-metallics.]

CHAPTER V.—HYDROGEN (*continued*).

VALENCY. ICE. WATER. STEAM. LATENT HEAT.

E. MIXTURES.—None is known.

COMPOUNDS. (α) *General.*—Hydrogen combines with every one of the non-metals, except, as far as is known, boron. A list of symbols and names of some of the compounds resulting follows:—

HH. = H^2...	Hydrogen	hydride	or hydrogen (really an element).
H_2O	,,	oxide	,, (water.)
H^3N	,,	nitride	,, (ammonia).
H^4C	,,	carbide	,, (light carburetted hydrogen).
HCl	,,	chloride	,, (hydrochloric acid).
HBr	,,	bromide	,, (hydrobromic acid).
HI	,,	iodide	,, (hydriodic acid).
HF	,,	fluoride	,, (hydrofluoric acid).
H^2S	,,	sulphide	,, (sulphuretted hydrogen).
H^3P	,,	phosphide	,, (phosphuretted hydrogen).
H^4Si	,,	silicide	,, (siliciuretted hydrogen).

From this list two principles may be learnt. Note that one atom of hydrogen combines with one atom of each of the following elements: hydrogen, chlorine, bromine, iodine, fluorine; that two atoms of hydrogen combine with one of each of the following: oxygen and sulphur; that three atoms of hydrogen combine with one atom of nitrogen and of phosphorus; and that four atoms of hydrogen combine with one atom of carbon and with one atom of silicon.

An element 1 atom of which unites with 1 atom of hydrogen = a monad; μονος (monos) = 1.

An element 2 atoms of which unite with 1 atom of hydrogen = a dyad; δύο (duo) = 2.

An element 3 atoms of which unite with 1 atom of hydrogen = a triad; τρεις (treis) = 3.

An element 4 atoms of which unite with 1 atom of hydrogen = tetrad; τεττερα (tettara) = 4.

Thus hydrogen, chlorine, fluorine are monads; oxygen and sulphur are dyads; nitrogen and phosphorus are triads; carbon and silicon are tetrads.

These names, monad, dyad, triad, tetrad, express what is called the *valency* of an element. Some elements, however, do not unite with hydrogen, and their valency has to be determined by noting how many atoms of hydrogen they replace it. Reference to the equation that represents the formation of hydrogen from water and potassium (see page 260) will show that one atom of potassium replaces one atom of hydrogen. H^2O or HHO is the symbol of water; KHO that of potash.

Reference to the equation that represents the formation of hydrogen from zinc and sulphuric acid will show that one atom of zinc replaces two atoms of hydrogen. H^2SO^4 is the symbol of sulphuric acid. $ZnSO^4$ that of zinc sulphate.

Hence the full definition of a monad is an element, one atom of which combines with or replaces one atom of hydrogen; of a dyad is an element, one atom of which combines with or replaces two atoms of hydrogen; of a triad, an element, one atom of which combines with or replaces three atoms of hydrogen; and of a tetrad, an element, one atom of which combines with or replaces four atoms of hydrogen.

There are higher valencies than the four just named. Some few elements act as pentads and hexads. The majority of the sixty-three elements are dyads. If, therefore, a list of the chief monads, triads, tetrads is given, the student will remember that all the elements with which he has to do, not in that list, are dyads.

Monads.

Hydrogen, chlorine, bromine, iodine, fluorine.....Potassium, sodium, silver.

Triads.

Nitrogen, phosphorus, boron.....Arsenic, antimony, bismuth, gold.

Tetrads.

Carbon, silicon.....Platinum, tin.

The second principle to be learnt from the list of symbols and compounds has to do with nomenclature. Only two elements are concerned in each compound represented there, whatever may be the number of atoms of each element present. The name of each compound is a double name. One word of the name is 'hydrogen.' This tells us that the element hydrogen is the positive electric constituent or basylous radicle of the compound. The other word tells us that some other element is the negative electric constituent or chlorous radicle, and this second word always ends in 'ide.' A like method is adopted in naming every compound of two elements. A few more symbols and names are given :—

KCl .....Potassium chloride.
NaBr.....Sodium bromide.
ZnS .....Zinc sulphide.
CO .....Carbon oxide.

Finally, the bulb, F, most to the right, is, at first, empty, and the tube beyond, C, contains calcium chloride. This bulb and tube must also be weighed. Before any heat is applied to the copper oxide, expel all air by a current of hydrogen evolved from the zinc and sulphuric acid. Then apply heat to the bulb, E, containing the oxide. The hydrogen, passing over the red-hot copper oxide, unites with the oxygen of that compound and forms hydrogen oxide, or steam. This condenses in the second bulb or in the calcium chloride tube beyond. Copper is left in the bulb, E, over the flame. Weigh this bulb at the end of the experiment. The loss of weight as compared with the weight before the experiment tells the weight of the oxygen in the water that is formed. Weigh the two last pieces of apparatus, F and G, most to the right. The gain in weight tells us the whole weight of the water formed. The difference between these two numbers is the weight of the hydrogen in the water that is formed. This is the synthetical method of determining the composition of water. συν (sun)=together, θησις (thesis)=a placing. Synthesis is, therefore, the putting together of bodies to form a compound.

No matter how many times this experiment or that of the analysis of water is repeated, the result is the same, if the experiments are conducted with care. Hence we are led to the first great law of chemical combination, that *chemical compounds always contain their components*

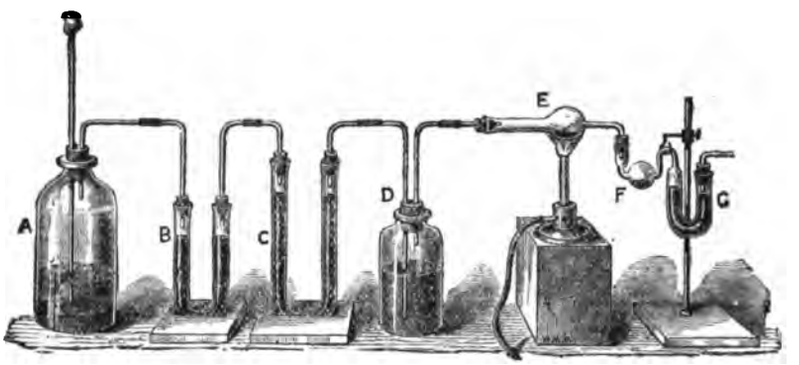


Fig. 16.

Of the long list given on page 494, only the second and third will be studied in connection with hydrogen. The others will be studied under the account of the element that is combined in each case with hydrogen.

(β) *Special. Hydrogen oxide.*—(*a*) *Symbol*, H^2O.
(*b*) *Weight-number*, 18.

(*c*) *Preparation.*—In the form of water this compound is so prevalent that its preparation is unnecessary, save as an interesting chemical experiment.

(1) *Laboratory Method.*—Burn hydrogen. This gas combining directly with oxygen, hydrogen oxide results.

(2) *Symbols.*— $2H^2 + O^2 = 2H^2O$.

(3) *Weight-numbers.*— 4 + 32 36.
4 vols. 2 vols. 4 vols.

Another preparation of hydrogen oxide is of interest also as showing the exact composition (by weight) of that compound.

(1) *Laboratory method.*—Arrange apparatus as shown in Fig. 16. The first bottle to the left, A, is one for the evolution of hydrogen by the action of sulphuric acid on zinc. The two succeeding bent tubes are partly filled with calcium chloride ($CaCl^2$). This substance absorbs any moisture that may be mixed with the escaping hydrogen. The fourth piece of apparatus is another bottle containing sulphuric acid. Thus, when the hydrogen gas passes, it is delivered dry and pure into the bulb, E, below the burner. In this bulb is some copper oxide (CuO), carefully dried by heat, and carefully weighed. *in the same unvarying proportions. This is called the law of constant proportion.*

(2) *Symbols.*— $Cu\ O + H^2 = H^2O + Cu$.
(3) *Weight-numbers and volumes.* $63 + 16 + 2 = 2 + 16 + 63$
79 18
2 vols.

QUESTIONS ON THE SYNTHESIS OF WATER (*solved*).

46. What weight of copper oxide is necessary for the formation of 36 cc. of water, and what volume of hydrogen must be passed over it?

36 cc. water weigh 36 grams.
18 grams H^2O need 79 grams CuO + 22·4 litres H,
1 gram „ needs $\frac{79}{18}$ gram „ + $\frac{22{\cdot}4}{18}$ „
36 grms. H^2O need $\frac{79 \times 36}{18}$ grams CuO + $\frac{22{\cdot}4 \times 36}{18}$ litres H.

158 grams CuO and 44·8 litres H.

47. 5600 cc. hydrogen are passed over red-hot copper oxide. What weight of copper is left?

22·4 litres = 22400 cc. H. passed over a sufficient quantity of CuO yield 63 grams Cu.
1 cc. H passed over a sufficient quantity of CuO yields $\frac{63}{22400}$ grams Cu.
5600 cc. H passed over a sufficient quantity of CuO yield $\frac{63 \times 5600}{22400}$ grams Cu.
$15\frac{3}{4}$ grams.

QUESTIONS ON THE SYNTHESIS OF WATER (*for solution*).

42. What weight of water will be formed by the passage of 4 grams hydrogen over an unlimited quantity of red-hot copper oxide? .....36 grams.

43. Required a litre of water. What weight of copper oxide, and what volume of hydrogen are needed?
4388⅞ grams; 1244⅛ litres.

This same compound, hydrogen oxide, is formed whenever any substance containing hydrogen as one of its elements is burned. If a bright glass is held over a burning candle or over a paraffin lamp, steam is found to be deposited on it. The tallow or wax of the candle has for one of its constituents hydrogen, and this gas joining with the oxygen of the air forms hydrogen oxide.

(*d*) *Properties.*—Hydrogen oxide exists in three forms—the solid ice, the liquid water, the gas steam.

(α) Ice.—1. *Condition.*—Solid; melting at 0°C.

2. *Effect on the Senses.*—Hard, brittle, tasteless, odourless, translucent.

3. *Specific gravity.*—Lighter than water, with which, like all solids, it is compared. Taking the specific gravity of water as 1 that of ice is ·9175. Hence, when water freezes, expansion takes place. This expansion, when water becomes ice, is the cause of the bursting of water-pipes in houses. The pipes, if full of water, burst when the frost comes, but the discovery of the mischief is made when the thaw sets in, and, the ice melting, the water flows through the flaws. This expansion is also the great agent in the disintegration of rocks. If the crevices of a rock are filled with water when the frost comes, the expansion caused by the water as it turns into ice breaks up the rocks. The lightness of ice as compared with water also explains the fact that ice floats on water.

4. *Solubility.*—Not soluble in water.

5. *Relation to Combustion.*—Not combustible.

6. *Specialties.*—When ice becomes water, a larger quantity of heat disappears than when any other solid is changed into its corresponding liquid. Whenever by the application of heat a solid is converted into a liquid heat disappears. Ice, *e.g.*, melts at 0°C. But the temperature of a mass of ice to which heat is applied does not rise beyond 0° until all the ice is turned into water. Thus, the heat of the fire applied to the ice melts it, without raising its temperature. The heat that was perceptible by its action upon the thermometer no longer affects that instrument. The mass of ice at 0° has become a mass of water at 0°. The heat has been rendered *potential* or *latent*. As soon as all the ice has become water, the continued application of heat will cause the temperature of the water to rise.

In the melting of every solid, heat becomes potential or latent. It has the power to do work, but is not doing work. It is not, for the time being, kinetic heat. κινησις (kinēsis) = movement. In the case of ice, a larger quantity of kinetic heat is rendered potential than in the conversion of any other solid into its corresponding liquid.

To understand how much heat passes from the kinetic to the potential condition when ice becomes water, the meaning of the phrase *heat-unit* must be explained. A heat-unit, or thermal unit, or gram-degree, is the quantity of heat necessary to raise the temperature of a gram of water from 0° to 1°. Note that this unit quantity of heat is by no means the same as a degree of temperature. These two quite different things must not be confounded.

20 grams of water raised from 0° to 1° require 20 heat-units.
20 „ „ „ „ 0° „ 10° „ 200 „ „
40 „ „ „ „ 10° „ 100° „ 3600 „ „

To convert 1 gram of ice at 0° into 1 gram of water at 0°, 79·2, or, approximately, 80 heat-units are required. Hence 1 gram of ice at 0° mixed with 1 gram of water at 80°, or mixed with 2 grams of water at 40°, or mixed with 80 grams of water at 1°, or mixed with 10 grams of water at 8°, would result in 2, 3, 81, 11 grams of water, respectively, at 0°.

Some examples on the potential heat of water will be given after the consideration of water itself.

(β.) Water.—1. *Condition.*—A liquid freezing at 0°, boiling at 100°. The freezing-point and boiling-point of water are respectively 0° and 100°, only under normal conditions. With varying external circumstances they vary. The freezing-point is not always 0°. By cooling water, out of contact with air and kept perfectly still, a temperature of −10° or −15° has been reached before the water becomes ice. The slightest shaking of the water causes it suddenly to turn into ice, the temperature rising at the same time to 0°.

The freezing-point alters also with variation of pressure. When water turns into ice, expansions occurs. Thus 1 vol. of water at 0° becomes 1·09082 of ice. Anything that retards this expansion will make the conversion of water into ice more difficult. Increase of pressure will retard the expansion. Hence, if the pressure on the water is increased, solidification of the water is rendered more difficult, and a lower temperature (or in ordinary language, 'more cold') is required. The melting-point is lowered ·0075° for every additional pressure equivalent to that of a column of mercury 760 mm in height.

The boiling-point is not always 100°. It may be either higher or lower than 100°. The chief circumstances affecting the boiling-point are pressure, the nature of the vessel in which the water is placed, and the presence of salts in solution in the water.

i. *Pressure.*—Increase of pressure raises the boiling-point. Diminution of pressure lowers the boiling-point. When water becomes steam, as it passes off it has to overcome the pressure of the air upon the surface of the water. Any increase of that pressure makes it harder work for the water to become steam, and a higher temperature (or, in ordinary language, 'more heat') is required. 27 mm., measured in mercury, increase or diminution of the pressure on the water causes the boiling-point to rise or fall 1°.

ii. *The Nature of the Vessel.*—Water in a vessel made of some material to which the water adheres will boil at a higher temperature than in a vessel made of a material to which the water does not adhere. Adhesion between the water and the sides of the vessel tells against the passage of the water into the state of steam.

iii. *Presence of Salts in Solution in Water.*—As in the preceding case, adhesion of water to the particles that it holds in solution tells against the water passing off as steam. Distilled water boils, therefore, at a lower temperature than water containing matters in solution.

2. *Effect on Senses.*—Pure water is without taste or odour, colourless and transparent, unless seen in large quantity.

3. *Specific Gravity.*—Since water is taken as the standard of comparison for liquids and solids, its own specific gravity is 1. Water is about 11,937½ times as heavy as hydrogen, say, 11,940. It is 825 times as heavy as air.

4. *Solubility.*—

5. *Relation to Combustion.*—Not combustible.

6. *Specialties.*—It is 'the universal solvent.' The student should try the effect of distilled water on common salt, which is readily soluble, plaster of Paris (slightly soluble), chalk (insoluble). He should, after making a solution of common salt or of common 'soda,' (really, sodium carbonate), and of copper sulphate, evaporate each of the three solutions and observe the dissolved solids crystallise out as the solvent water passes off in the form of steam.

As a rule, the higher the temperature of the water, the more does it dissolve of the soluble substance, if the latter is a solid. In making a solution of a solid body, the force of cohesion between the particles of the solid has to be overcome. The adhesion between the water and the solid particles is in opposition to this cohesion and overcomes it when the solution is made. Heat, however, helps adhesion as it tends to separate the particles of the solid one from the other, and tells against the cohesion.

On the other hand, gases are less soluble in hot water than in cold. In gases the force of cohesion is *nil*. The particles of a gas are already repelling one the other.

Hence a rise of temperature in this case tells against the adhesion between the water and the gas.

From the experiments on page 260 and page 378 it will be seen that water is decomposed by sodium or potassium at the ordinary temperature, and by iron at a red heat. Other metals, such as copper and platinum, do not decompose water under any circumstances. Water combines with certain metallic compounds with great evolution of heat. Thus, if it is poured on quicklime (CaO), it unites with that compound to form calcium hydrate, and in the union much heat is evolved.

$$\underset{40+16}{CaO} + \underset{2+16}{H^2O} = \underset{40+2\,(1+16)}{Ca\,(HO)^2}$$
$$\underbrace{\quad}_{56} \quad \underbrace{\quad}_{18} \quad \underbrace{\quad\quad}_{74}$$

The effect of heat on water is peculiar. The majority of bodies when heated expand. If water at 0° has its temperature raised, instead of expanding it contracts until the temperature of 4·5° is reached. Then, if the temperature is still raised, the water behaves like liquids generally and expands regularly. Hence, if water at 4·5° is either cooled or heated it expands. This temperature is therefore called the point of maximum density of water. From this remarkable property of water it follows that when the surface of a mass of water, such as a lake, is cooling from the ordinary temperature of the air (say, 15°) downwards to 4·5°, that surface becoming cooler than the underlying regions of water is heavier than these, and constantly falls down. The lighter, hotter, originally underlying water, rising takes its place, and in its turn is cooled, becomes heavy, and falls. But when the temperature of 4·5° is reached, the upper layer of water begins to expand, is lighter than the water beneath it, and floats at the top. This it continues to do as the temperature falls from 4·5° to 0°, and then the surface water freezing, and again expanding as it freezes, the ice, a non-conductor of heat, is at the top of the lake and warmer water underneath.

The next special point to be considered in regard to water is of the same nature as that on which I dwelt for some time in considering ice. When water becomes steam a larger quantity of heat disappears than when any other liquid is changing into its corresponding gas. Whenever, by the application of heat, a liquid is converted into a gas, heat disappears. Water, *e.g.*, boils at 100°. But the temperature of a mass of water to which heat is applied does not rise beyond 100° until all the water is turned into steam. Heat is rendered potential or latent. As soon as all the water has become steam, the continued application of heat will cause the temperature of the steam to rise.

The number of heat units that are converted from the kinetic to the potential condition when 1 gram of water at 100° becomes 1 gram of steam at 100° is 536.

(To be continued.)

—o—

The New Class-Subject, 'Elementary Science.'

(What to teach, and how to teach it.)

BY RICHARD BALCHIN.

It is a great advantage to both teacher and scholar that the examination of the 'class-subjects' is generally oral and not written. With such young minds as we have to deal with, where the knowledge acquired is always far in advance of the ability to express it, it is an injustice to the teacher and a discouragement to the pupil to insist upon a written examination. Moreover, such a method of testing leads, in some cases, to mere cram, and to the learning by memory of certain answers to a few stereotyped questions; by which means, the whole purpose of science teaching is entirely frustrated. Indeed I have always felt sorry that the examination of even the specific subjects is by means of written answers only; in these cases, however, as the grant is given upon individual passes, I suppose an exclusively oral examination would be impracticable.

I would here impress upon the teacher the advisability of always performing the proposed experiment by himself before the class meets. I so often find that where this is not done the experiment is a complete failure, and the class is thrown into confusion.

The following simple notes form a continuation of the syllabus which appeared in the October issue of this magazine.

LESSON XVI.—THE CHEMISTRY OF WATER (*a*).

Water exists in nature in the three states—solid, liquid, and gaseous. In all three states, it has, of course, the same composition. It is an oxide—the protoxide of hydrogen, H_2O. When water is separated into its elements, these appear as the two gases, hydrogen and oxygen. Here refer to a previous lesson for the main characters of those gases; and contrast those characters with the properties possessed by the compound. There are two volumes of H to one of O; or sixteen parts by weight of oxygen to two of hydrogen. Water may be analysed by (*a*) heat, (*b*) by electricity, (*c*) by displacement.

First by heat. It was the opinion of Captain Shaw, of the London Fire Brigade, that when water was poured into an intensely hot part of a burning building the fire blazed up with greater fierceness. The water was, in fact, decomposed; giving rise to hydrogen, which at once inflamed, and to oxygen, which supported the combustion. Picture these effects before the boys. If possible, perform the following experiment. Get a piece of ½-inch iron pipe (gas pipe) two feet long. Weigh out exactly two ounces of very small iron brads, or, preferably, some clean iron turnings. Stuff them into the middle part of the pipe. This can be done by ramming them from both ends of the pipe with two pieces of iron rod. Fix into each end of the pipe, by means of perforated corks, a length of glass tubing. Fit the free end of one tube into the neck of a flask containing water to be boiled. Let the free end of the other tube dip under a collecting jar at the pneumatic trough. Light at least *two* Bunsen burners, and place them under the middle part of the iron tube, so as to make it, and the iron turnings within it, red hot. Boil the water in the flask, over a spirit lamp. The invisible water-vapour from the flask passes into the iron pipe and over the red-hot iron turnings: these absorb the oxygen from the H_2O, and form an oxide of iron—the black oxide, Fe_3O_4; while the remaining hydrogen passes out of the iron pipe and may be collected in the usual way and tested.

$$4H_2O + Fe_3 = Fe_3O_4 + 4H_2.$$

This experiment demonstrates the composition of water by analysis. If the iron turnings be now cleared out of the pipe and weighed, the boys will see what they have gained by their union with oxygen.

A supplementary lesson may be given to demonstrate the composition of water synthetically. Get some hydrogen, by displacing it by means of the

metal zinc from dilute sulphuric acid; and burn a jet of it in a cool bell-jar, to the interior of which introduce a supply of oxygen. A large quantity of water-vapour is formed, which condenses upon the inner surface of the jar.

LESSON XVII.—THE CHEMISTRY OF WATER (*b*).

Water may be decomposed into its elements by electric force. This method of analysis is termed the 'electrolysis' of water. The two elements thus obtained are the gases hydrogen and oxygen. It is the general opinion that this electrolysis of water is performed on a grand scale in nature. This has been alluded to in a former lesson. The electrical discharges in the atmosphere—*i.e.*, lightning—decompose some of the aqueous vapour always present in the air. The hydrogen of the water combines with the nitrogen of the air to form ammonia, NH_3, and the oxygen of the water is concentrated into a condensed form called ozone, O_3. (*Note.*—In my last article, ozone was, by a printer's error, given as NO_2; it should have been O_3.)

To analyse water by electric force, get two, at least, of Grove's cells. Invert two test tubes filled with water over a basin of the same, so that the tubes just dip into the liquid, which should be acidulated with a little sulphuric acid, as water is a non-conductor. To the ends of the wires from the battery join small platinum plates; pass these up a short distance into the test tubes, and then set the cells to work by pouring some dilute sulphuric acid around the zinc plate for the positive pole; and strong nitric acid around the platinum plate in the porous cells of the battery for the negative pole. Bubbles of gas now appear, covering the small plates in the test tubes. That at the positive pole is oxygen, that at the negative pole is hydrogen. These gases rise in the tubes and displace the water. The hydrogen is, in volume, double of the oxygen.

Note.—When performing this experiment with very small long test tubes, it is soon seen that the vols. of hydrogen and oxygen are in a greater ratio than 2 : 1; but this is in consequence of the greater solubility of oxygen in water than of hydrogen. (100 vols. of water at 15° C. absorb 1·93 vols. of hydrogen and 2·99 vols. of oxygen.)

This experiment demonstrates the composition of water by electrical analysis; but the same may be demonstrated by electrical synthesis. Thus: if the two gases, H and O, be mixed in the proportion of 2 to 1 in a strong glass tube and exploded by the electric spark, the *whole* of the gases disappear and water is formed. If the gases be mixed in a different proportion than 2 to 1, still it is only in this proportion they combine; the excess in either case is left behind.

LESSON XVIII.—THE CHEMISTRY OF WATER (*c*).

The composition of water may also be demonstrated by the absorption of its oxygen by means of some substance which has a powerful affinity for this element. The substances usually employed for this purpose are the metals sodium (Lat. natrium) and potassium.

Show the boys a piece of sodium. Looks like chalk. Cut it through with a penknife; note the metallic, leadlike lustre, and the coating of white powder. The powder is the oxide of sodium, Na_2O. Oxygen has a great affinity for sodium. Have ready a basin or an iron saucer of water; throw a piece of sodium, half the size of a pea, on the water. Note the following facts. It is lighter than water, and floats. (Sp. gr. of sodium, 0·97.) It becomes hot, and melts to a liquid globule of silvery brilliancy, which floats about with a hissing noise, accompanied sometimes with flame. This is a beautiful and most suggestive experiment. We have the separation of water into its elements, hydrogen and oxygen; the rapid union of the oxygen with the metal to form the oxide. This combination generates heat.

(If the intelligence of the class is above the average, draw a word-picture to the boys, of the fierce dashing and clashing together of the millions of atoms of oxygen (torn from the liquid) with the atoms of sodium; and of the motion—chemical force or affinity—being translated into the motion, heat.)

The heat thus generated melts the sodium. (Sodium fuses at 194° F.) The hissing noise is the escape of the hydrogen, liberated from the water. The molten metal getting intensely hot, a heat is generated sufficient to inflame the hydrogen. The incidental facts connected with this experiment are most instructive; such as the globular form assumed by the metal, the instant it becomes liquid; the rapid motion of the globule, due to the force of the escaping hydrogen, and probably to the conversion of some of the water to steam immediately under the globule.

The hydrogen may be collected by wrapping the fragment of sodium in a small piece of blotting-paper, and holding the same in a coil of wire down in water under an inverted test-tube also filled with water.

LESSON XIX.—COMPOUNDS OF OXYGEN.

Oxygen has so great an affinity, either directly or indirectly, with all the other elements, with the single exception of fluorine, that we may expect to find many important compounds of it. Recapitulate the fact and illustrations, that *burning* or combustion is really the act of combination of certain substances with oxygen. First we will take the compounds of oxygen with iron. Symbol for iron is Fe (Lat. ferrum).

Get a rusty nail, rub off the rust on to a boy's finger; this rust is an oxide of iron. Show the class a small bottle of water in which a few iron brads have been soaked; the water is coloured red, by oxide of iron. Show a piece of white sandstone, or bottle of white sand; and a piece of red sandstone, or bottle of red sand. Redness due to the presence of an oxide of iron. In the case of the red sandstone, some water containing iron (*e.g.*, a mineral spring) has soaked into a bed of sand and consolidated it into a red stone.

Refer to the experiment described in Lesson XVI., where iron at a red heat combines with the oxygen of water-vapour to form the black oxide of iron, Fe_3O_4. The red oxide of iron, often found as an iron-ore, and called 'hœmatite,' is Fe_2O_3. The simplest oxide is the protoxide FeO; but so great is the affinity of oxygen for iron, that unless this compound be kept from contact with oxygen it combines further with the latter and forms higher oxides.

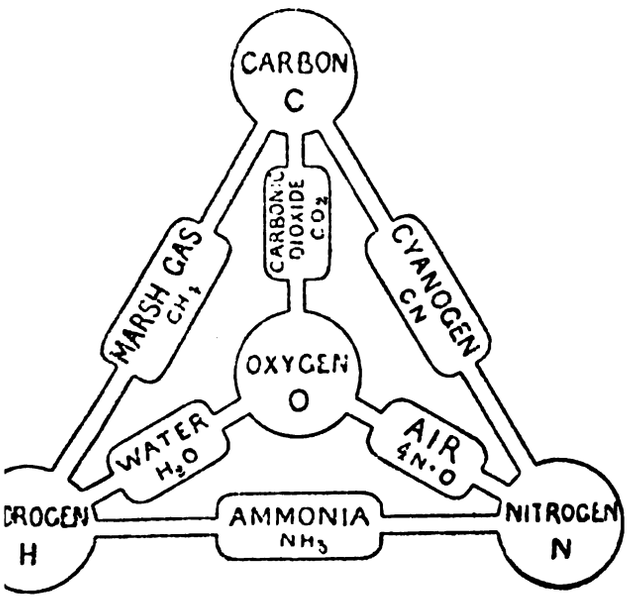
Cold iron does not combine with the oxygen of the atmosphere, but only with the moisture contained in the latter. If, however, an iron poker be frequently

placed in the fire and made red-hot, the iron gets coated with a layer of red oxide, which cakes off, and, as the boys will have observed, the poker gets smaller and smaller.

LESSONS XX. TO XXII.

The substance of these lessons on the further compounds of oxygen is given with sufficient fulness in the 'Science Reader' for Standard V. On page 140 of that book there is a diagram which the teacher will find extremely useful. I have enlarged it to six feet by four; and it is always up before the class during a lesson. In addition to what is on the diagram I have placed under each element and compound its symbol or formula. To question frequently upon the various combinations figured in this striking diagram is invaluable as a recapitulatory exercise.

Diagram showing the chief combinations of oxygen, etc.



(To be continued.)

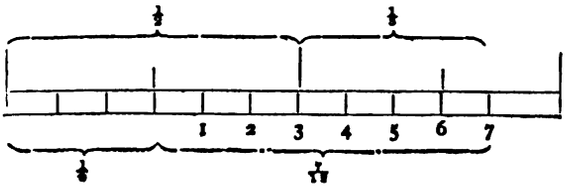
My Scholarship Answers.

BY H. D'ALBERTANSON.

First on the Scholarship List, 1884.

Arithmetic.

1. (*b*) Make a diagram showing that :—$\frac{1}{2}+\frac{1}{3}-\frac{1}{4}=\frac{7}{12}$.



(*c*) Show that not more than four aliquot parts are required for finding by practice the value of 3178 articles at £1 13s. 9½d. each.

10s.	½	3178 at £1 13s. 9½d.
3s. 4d.	⅓	£1589 = cost of 3178 at 10s.
5d.	¼	£529 13s. 4d. = " " " " 3s. 4d.
½d.	1/120	£66 4s. 2d. = " " " " 5d.
	of	£9 18s. 7½d. = " " " " ½d.
10s.		£5372 16s. 1½d. = Cost of 3178 at £1 13s. 9½d.

(*c*) How would you prove the correctness of the ordinary method of converting the vulgar fraction $\frac{7}{16}$ into a decimal?

$$16)7\cdot0000$$
$$\cdot4375$$

Now $\cdot4375=\frac{4375}{10000}=\frac{4375\div625}{10000\div625}=\frac{7}{16}$. Q. E. D.

3. Find the number of yards of paper 2 ft. wide required for a room 35 ft. long, 25 ft. wide, and 10 ft. high, allowing for a door 7 ft. high and 6 ft. wide, two windows, each 6 ft. high and 4 ft. wide, and a fireplace covering 18 sq. ft.

Sq. ft.
7×6 = 42 Area of door
$6\times4\times2$ = 48 " " windows
18 " " fireplace
∴ 108 sq. ft. = amount to be deducted.

ft. ft. sq. ft.
$35\times10\times2$ = 700
$25\times10\times2$ = 500
∴ 1200 sq. ft. = Total area of 4 sides of room.
108
2)1092 sq. ft. = Area to be papered.
3) 546 ft. = No. of ft. of paper.
182 yds. Ans.

4. The value of a Spaniard's work to that of a Frenchman's being as 3 : 4, and their daily rate of wages being 5s. and 7s. respectively; find the gain obtained by employing 100 Spaniards for 21 days instead of Frenchmen.

4 Sp. = 3 Fr.
∴ 1 Sp. = ¾ Fr.
∴ 100 Sp. = $\frac{3\times100}{4}$ Fr.

∴ $\frac{\overset{25}{\cancel{100}}\times\overset{}{\cancel{5}}\times21}{\cancel{20}\ \cancel{4}\ 5}=525$ = Cost of 100 Sp. for 21 days.

And $\frac{3\times\cancel{100}\times7\times21}{4\times\cancel{20}}=$£551 5s. = Cost of Fr. for 21 days.
∴ £551 5s. − £525 = £26 5s. Ans.

5. If 4 ac. 2 ro. 39 ps. of land cost £768 9s. 9d. what would 9 ac. 2 ro. 13 ps. cost?

ac. ro. ps. ac. ro. ps. £ s. d.
4 2 39 : 9 2 13 :: 768 9 9
4 4
18 38
40 40
759 1533
511

∴ $\frac{\text{£768 9s. 9d.}\times\cancel{1533}}{\cancel{759}\ 253}=$£3 0s. 9d. × 511 = £1552 3s. 3d. Ans.

6. What fraction of 4s. 7d. will exceed ⅔ of 5⅛ of 2s. 1d. by 1s. 5d.?

$(\frac{2}{3}\text{ of }5\frac{1}{8}\text{ of 2s. 1d.})+1\text{s. }5\text{d.}=\left(\frac{3}{7}\times\frac{\overset{4}{\cancel{8}}}{\cancel{8}}\times\frac{\overset{5}{\cancel{40}}}{1}\right)+17=$

$60+17=77\text{d.}\ldots\frac{77\text{d.}}{4\text{s. }7\text{d.}}=\frac{77}{55}=\frac{7}{5}=1\frac{2}{5}$. Ans.

7. Add together 1·3 of 2s. 6d., 1·025 of 1s. 8d., 3·7 of 2s. 0½d., 3·15 of 2s. 9½d., and reduce their sum to the decimal of £1.

			s.	d.
1·3	of 2s. 6d.	$=1\frac{3}{10}$ of 2s. 6d. = 2s. 6d. +	9	= 3 3
1·025	of 1s. 8d.	$=1\frac{1}{40}$ of 1s. 8d. = 1s. 8d. +	½d.	= 1 8½
3·7	of 2s. 0½d.	$=3\frac{7}{10}$ of 2s. 0½d. = 6s. 2½d. +	1s. 7½d.	= 7 9½
3·15	of 2s. 9½d.	$=3\frac{3}{20}$ of 2s. 9½d. = 8s. 5½d. +	5½d.	= 8 10½
				21 7½

s. d.

$\therefore \frac{21\ 7\frac{1}{2}}{20s.} = \frac{259\frac{1}{2}}{240} = \frac{5\,18\,1}{4\,80} = \underline{1{\cdot}08125}$. Ans.

10. Find the breadth of a tank 70 ft. long and 3 ft. deep, which contains 36288 gallons (a gallon contains 277·274 cubic inches).

6

inc. ft.

$\frac{277{\cdot}274 \times 36288}{70 \times 3} = \frac{1663{\cdot}644}{5 \times 12} = \frac{332{\cdot}7288}{12} = \underline{27{\cdot}7274}$ ft. Ans.

5

11. Find in inches to three places of decimals the side of a square which contains 41·9 square ft.

41·9
144
1676
1676
419
6033·6(77·676...inc. Ans.
49
147)1133
1029
1546)10460
9276
15527)118400
108689
155346)971100
932076

12. Find the annual rent of a house on which, after deducting 20 per cent., a rate of 3s. 1d. in the pound produces a sum of £38 17s.

s. d. £ s. £

3 1 : 38 17 :: 1 : x = Rent − 20 per cent.

12 20

37 777

12

37)9324(£252 = Rent − 20 per cent. or $\frac{1}{5}$

74

192 $\therefore \frac{4}{5}$ of Rent = 252

185 $\therefore \frac{1}{5}$ „ „ = $\frac{252}{4}$

74 $\therefore \frac{5}{5}$ „ „ = $\frac{252 \times 5}{4} = \underline{£315}$. Ans.

74

13. Find the length of a floor 18 ft. wide; the difference of cost if covered with asphalte 2 inches deep at 18s. per cubic yard or with gravel 6 in. deep at 7s. per cubic yard amounting to £6.

s.

If 36 in. deep the cost of 1 sq. yd. of asphalte = 18

$\therefore$ If 1 „ „ „ „ „ 1 sq. yd. „ „ = $\frac{18}{36}$

$\therefore$ If 2 „ „ „ „ „ 1 sq. yd. „ „ = $\frac{18 \times 2}{36} = 1s.$

s.

If 36 in. deep 1 sq. yd. of gravel costs 7

$\therefore$ If 1 „ „ 1 „ „ „ $\frac{7}{36}$

$\therefore$ If 6 „ „ 1 „ „ „ $\frac{7 \times 6}{36} = 1\frac{1}{6}s. = 1s.\ 2d.$

s. d. s. d. d.

$\therefore$ Diff. of cost for 1 sq. yd. = 1 2 − 1 0 = 2

$\therefore \frac{£6}{2} = \frac{240 \times 6}{2} = 720$ = No. of sq. yds. in floor

sq. yds.

$\therefore$ Length = $\frac{720}{18\text{ ft.}} = \frac{720 \times 9}{18} = \underline{360}$ ft. Ans.

14. A wine merchant buys 500 galls. of brandy at 40s. per gall., and 600 at 50s. per gall. At what price should he sell them mixed together to make a gain of 10 per cent.?

£

500 at £2 = 1000

600 at £2½ = 1500

$\therefore$ Cost price of 1100 galls. is 2500

10 per cent. of 2500 = 250

$\therefore$ Selling price of 1100 galls. is 2750

$\therefore$ „ „ 1 gall. is $\frac{2750}{1100} = \underline{£2\ 10s.}$ Ans.

15. A person invests in the 3 per cents. so as to obtain interest at the rate of £2 19s. $3\frac{81}{119}$d. per cent. per annum. Find the price of stock.

£ s. d. £ £

2 19 $3\frac{81}{119}$: 3 :: 100

20 240

59 720

2 809

711 6480

809 57600

6399 576)58248(101½. Ans.

56880 576

801 648

576 576

72

Euclid.

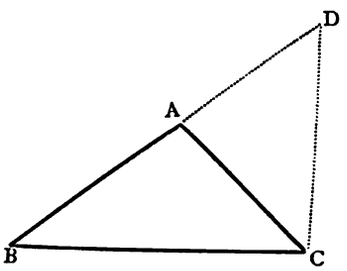
1. Any two sides of a triangle are greater than the third side.

If a straight line be drawn from the vertex of a triangle bisecting the base, the line together with half the base is greater than half the sum of the two sides.

Any two sides of triangle ABC are greater than the third.

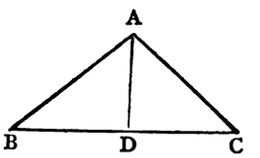
Produce BA to D, making AD = AC (I. 3).

Join DC.



$\because$ AD = AC, $\therefore$ angle ADC = angle ACD (I. 5).

But BCD is greater than ACD (Ax. 9). $\therefore$ BCD is greater than ADC. And $\because$ BCD is greater than BDC, $\therefore$ side BD is greater than side BC (I. 19). But BD is = BA and AC (Const.) $\therefore$ BA and AC are greater than BC. In same manner it may be proved that AC and BC are greater than BA, and CB and BA than AC. Wherefore any two sides, etc. Q. E. D.



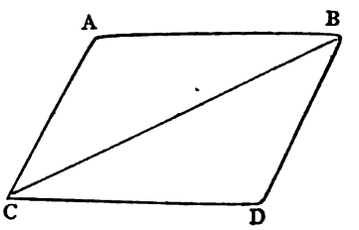
Let AD be drawn bisecting the base, then AD and BD or DC is greater than ½(AB and AC).

$\because$ AD and DB are greater than AB (I. 20), and AD and DC are greater than AC (I. 20), also DC = BD (Hyp.). $\therefore$ 2AD and 2BD are greater than AB and AC. Wherefore AD and BD are greater than half of AB and AC (Ax. 7). Q. E. D.

(2) Every parallelogram is bisected by its diameter.

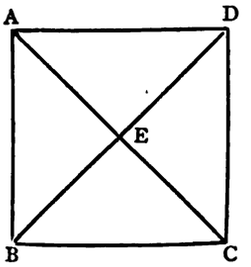
Under what conditions will the lines bisecting the opposite angles of a parallelogram be coincident?

The parallelogram ABCD is bisected by its diam. CB.



$\because$ AB = CD (I. 34, former part), and angle ABC = angle BCD, also CB is common to two triangles, ABC, BCD. $\therefore$ triangle ABC is = triangle BCD (I. 4). *Wherefore* ABDC is bisected by BC. Q. E. D.

In parallelogram ABCD let BE, ED, bisecting the angles ABC and ADC, be coincident, also the lines AE, EC bisecting BAD and BCE, and let the two diagonals thus formed cut at E.



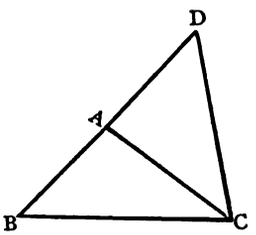
The figure ABCD is a square. ∵ angle ADB=DBC (I. 27), and DBC=ABD (Hyp.) ∴ ADB=ABD (Ax. 1). ∴ side AB=AD (I. 6), and the sides opposite to these are equal (I. 34). ∴ the figure ABCD is equilateral.

Again, ∵ ABD=ADE and BAE=DAE (Hyp.), also side AB=side AD. ∴ angle AEB=angle AED (I. 26). Wherefore each of them is a right angle (I. 14). And ∵ AEB is a right angle, ∴ ABE and BAE are together=a right angle (I. 32), but ABE has been proved=BAE (I. 26). ∴ ABE and BAE are each=half a right angle, and the wholes BAD and ABC are each=a right angle. Wherefore the fig. is rectangular, and it was proved equilateral. It is, therefore, a square (I. Def. 30).
Q. E. D.

(3) If the square described on one of the sides of a triangle be equal to the squares on the other two sides of it, the angle contained by these two sides is a right angle.

Write out the corresponding formula for the square on the side of an obtuse-angled triangle.

Let the square on BC be=sqs. on AB and AC, then BAC is a right angle.

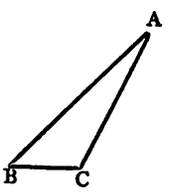


At A make CAD a rt. angle (I. 23), and make AD=AB (I. 3).

Join DC. ∵ sq. on DC=sqs. on AD and AC (I. 47), and AC=AD, ∴ sq. on DC=sqs. on AB and AC=sq. on BC (Hyp. and Ax. 1). ∴ DC=BC.

Again, ∵ DC=BC, AC is common, and AB=AD, ∴ triangle ABC is=triangle ADC (I. 8). ∴ angle BAC is=angle DAC, but DAC is a rt. angle. ∴ BAC is a right angle. Wherefore, if the sq. described, etc. Q. E. D.

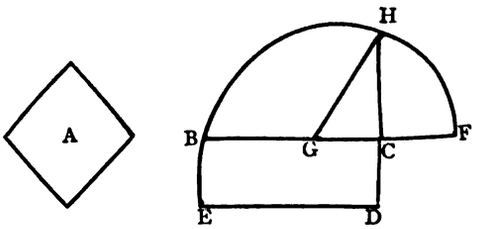
If the square described upon one side of a triangle be greater than the squares described upon the other two sides of it, the angle contained by these two sides is an obtuse angle.



Let sq. on AB be greater than sqs. on BC and AC, BCA is an obtuse angle, for it cannot be a rt. angle (I. 47), neither can it be an acute angle (II. 13). It must ∴ be an obtuse angle.

4. To describe a square that shall be equal to a given rectilineal figure.

To divide a given straight line into two parts so that the rect. contained by the two parts shall be equal to the sq. on one-fourth of the given line.



Describe the rectangle BEDC=given fig. A (I. 45).

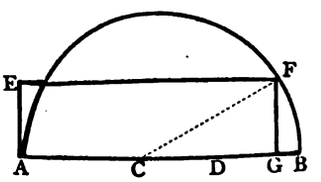
If BC=CD, the fig. is the required sq. But if not, produce BC to F, making CF=CD (I. 3). Bisect BF in G (I. 10), and from centre G with radius GB or GF describe semi-circle BHF. Produce DC to H. The sq. on CH is the required sq.

Join GH. ∵ The sq. on GF is=the rect. BC.CF, and the sq. on GC (II. 5) and GF is=GH (I., Def. 15). ∴ the sq. on GH is=the rect. BC.CF, and the sq. on GC (Ax. 1). But the sq. on GH is=the sqs. on GC and CH. Take away the common sq. on GC, and the remaining sq. on HC is=the remaining rectangle BC.CF, but CF=CD (Cons.) ∴ the sq. on HC is=rect. BD.

Again, BD is=A. ∴ sq. on HC is=A (Ax. 1). Q. E. D.

Bisect AB in C, and CB in D (I. 10). Then DB=one-fourth of AB.

Upon AB describe semi-circle AFB, and at A draw AE at rt. angles to AB and=BD (I. 11). Draw EF parallel to AB (I. 31), and FG parallel to EA.



The rect. AG.GB is equal to sq. on FG=sq. on DB=sq. on one-fourth of AB. Proof as above (II. 14) by joining FC, etc.
Q. E. D.

Algebra.

7. Write down the factors of $x^2+3x-10$, x^6-1, $9x^2+15x-14$. Add together $\frac{1}{a-b}+\frac{1}{b-c}+\frac{1}{c-a}$.

$$x^2+3x-10=(x+5)(x-2)$$
$$x^6-1=(x^3+1)(x^3-1)$$
$$=(x+1)(x^2-x+1)(x-1)(x^2+x+1)$$
$$=(x+1)(x-1)(x^2-x+1)(x^2+x+1)$$
$$9x^2+15x-14=(3x+7)(3x-2).$$

$$\frac{1}{a-b}+\frac{1}{b-c}+\frac{1}{c-a}$$
$$=\frac{(b-c)(c-a)+(a-b)(c-a)+(a-b)(b-c)}{(a-b)(b-c)(c-a)}$$
$$=\frac{bc-ab-c^2+ac+ac-a^2-bc+ab+ab-ac-b^2+bc}{(a-b)(b-c)(c-a)}$$
$$=\frac{ab+ac+bc-a^2-b^2-c^2}{(a-b)(b-c)(c-a)}. \quad \text{Ans.}$$

8. Divide $7x^3-\frac{1}{7}$ by $x+\frac{1}{7}$, and find the value of $\frac{x^2+y^2}{x^2-y^2}$ when $x=\frac{a+b}{a-b}$ and $y=\frac{a-b}{a+b}$.

$$x+\tfrac{1}{7}\overline{)7x^3-\tfrac{1}{7}}\,(7x-1. \quad \text{Ans.}$$
$$7x^3+x$$
$$-x-\tfrac{1}{7}$$
$$-x-\tfrac{1}{7}$$
$$- \quad -$$

$$\frac{x^2+y^2}{x^2-y^2}=\frac{\left(\frac{a+b}{a-b}\right)^2+\left(\frac{a-b}{a+b}\right)^2}{\left(\frac{a+b}{a-b}\right)^2-\left(\frac{a-b}{a+b}\right)^2}$$

$$\frac{(a+b)^4+(a-b)^4}{\frac{(a-b)^2(a+b)^2}{(a+b)^4-(a-b)^4}}=\frac{(a+b)^4+(a-b)^4}{(a+b)^4-(a-b)^4}$$

$$=\frac{(a^4+4a^3b+6a^2b^2+4ab^3+b^4)+(a^4-4a^3b+6a^2b^2-4ab^3+b^4)}{(a+b)^4-(a-b)^4}$$

$$=\frac{2a^4+12a^2b^2+2b^4}{8a^3b+8ab^3}=\frac{a^4+6a^2b^2+b^4}{4(a^3b+ab^3)}=\underline{\frac{a^4+6a^2b^2+b^4}{4ab(a^2+b^2)}}.$$ Ans.

9. Solve the equations:—

(1) $\frac{5x-9}{8}+\frac{7x-1}{10}=\frac{11x+7}{15}+6.$

(2) $\left.\begin{aligned}\frac{2x+2}{10}&=\frac{5y-11}{4}+1\\ \frac{3x}{2}+\frac{5y}{4}&=25\tfrac{1}{2}\end{aligned}\right\}$

$$\frac{5x-9}{8}+\frac{7x-1}{10}=\frac{11x+7}{15}+6$$

Multiply by 120, then

$$75x-135+84x-12=88x+56+720$$
$$\therefore\ 75x+84x-88x=56+720+12+135$$
$$\therefore\ 71x=923$$
$$\therefore\ \underline{x=13}.$$ Ans.

(2) $\frac{3x+2}{10}=\frac{5y-11}{4}+1$ (I.)

$\frac{3x}{2}+\frac{5y}{4}=25\frac{1}{2}$ (II.)

Multiply both equations by 20.

From (I.) $6x+4=25y-55+20$

$\therefore\ 6x-25y=-39$ (III.)

From (II.) $\underline{30x+25y=505}$ (IV.)

By addition $36x=466$

$\therefore\ x=\frac{466}{36}.$

$=\underline{12\tfrac{17}{18}}.$

Multiply (III.) by 5, then $30x-125y=-195$

Subtract (IV.) $\underline{30x+25y=505}$

Then $150y=700$

$\therefore\ y=\frac{700}{150}.$

$=\underline{4\tfrac{2}{3}}.$ Ans.

10. In the quadratic equation $x^2+ax+b=0$, show that $-a$ = the sum of the roots.

Solve the equation $2x+\sqrt{x^2+7x+23}-25=0.$

$x^2+ax+b=0\ \therefore\ x^2+ax=-b$

$$\therefore\ x^2+ax+\left(\frac{a}{2}\right)^2=\frac{a^2}{4}-b$$

$$\therefore\ x+\frac{a}{2}=\pm\frac{\sqrt{a^2-4b}}{2}\ \therefore\ x=\frac{\sqrt{a^2-4b}-a}{2}$$

$$\text{or}\ \frac{-\sqrt{a^2-4b}-a}{2}$$

$$\therefore\ \frac{\sqrt{a^2-4b}-a}{2}+\frac{-\sqrt{a^2-4b}-a}{2}=\frac{-2a}{2}$$

$=\underline{-a}.$ Q. E. D.

$$2x+\sqrt{x^2+7x+23}-25=0$$
$$\therefore\ \sqrt{x^2+7x+23}=25-2x.$$

By squaring, $x^2+7x+23=625-100x+4x^2$

$$\therefore\ 3x^2-107x=-602$$
$$\therefore\ x^2-\tfrac{107}{3}x+(\tfrac{107}{6})^2=\tfrac{11449}{36}-\tfrac{7224}{36}$$
$$=\tfrac{4225}{36}$$
$$\therefore\ x-\tfrac{107}{6}=\pm\tfrac{65}{6}\ \therefore\ x=\tfrac{107}{6}\pm\tfrac{65}{6}=\underline{28\tfrac{2}{3}\text{ or }7}.$$ Ans.

11. An avenue is planted with trees 20 ft. apart; if the trees had been planted 15 ft. apart the cost would have been increased by £5 at 2s. for each tree; find the length of the avenue.

Let x = Length of the avenue.

Then $\frac{x}{20}+1$ = No. of trees in first case.

And $\frac{x}{15}+1$ = No. of trees in second case.

$$\therefore\ 2\left(\frac{x}{20}+1\right)+100=2\left(\frac{x}{15}+1\right)$$

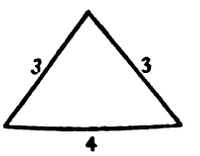
$$\frac{x}{10}+2+100=\frac{2x}{15}+2$$

Multiply by 30, $3x+60+3000=4x+60$

$\therefore\ \underline{x=3000}$ ft. Ans.

Mensuration.

12. Show that the area of a triangle whose sides are in the ratio 3 : 3 : 4 is greater than $\frac{1}{3}$ the area of a square described on one of the shorter sides.



$3\times3=9=$ Area of sq. $\therefore\ \frac{1}{3}$ of $9=4=\frac{4}{9}$ of area of sq.

$$\frac{3+3+4}{2}=5$$

$\therefore\ 5\times2\times2=20=$ Sq. of the area of triangle.

$20\overline{)4\cdot4\ldots}=$ Area of triangle.

16

$84\overline{)\cdot400}$

$\underline{336}$

Area of triangle $=4\cdot4\ldots$

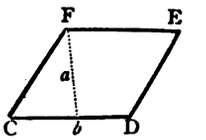
$\frac{1}{3}$ Area of sq. $=\underline{4}$

$\therefore$ Area of triangle is greater by $\underline{\cdot4\ldots}$ Q. E. D.

13. Find the length of the side of a parallelogram, one angle being half a right angle, the altitude being equal to half the base and the area containing 1250 sq. ft.

$a=\frac{1}{2}b\ \therefore\ \frac{1}{2}b\times b=1250\ \therefore\ \frac{1}{2}b^2=1250$

$\therefore\ b^2=2500\ \therefore\ b=\underline{50}=$ the base.



Because angle at C is half a right angle, $\therefore$ CFB is = half a right angle (I. 32).

$\therefore\ Cb=a=\frac{1}{2}b=25.\ \therefore\ CF=\sqrt{25^2+25^2}$

$=\sqrt{1250}=\underline{35\cdot35\ldots}$ Ans.

School Management.

1. Write full notes of a lesson on a complex sentence.

Introduction.—Write upon blackboard a simple sentence, as 'Honest men are happy,' and analyse. Show that the attribute, 'honest' may sometimes be 'a sentence itself, and convert the given sentence into 'Men *who are honest* are happy.'

Meaning of a subordinate sentence. Point out that the sentence 'who are honest' cannot be used by itself; it belongs to the noun, men, and thus depends upon the sentence, 'Men are happy.' Explain that such sentences are called '*subordinate*,' while sentences like 'Men are happy,' which can be used by themselves, are called *principal*.

Children may now note down: A subordinate sentence is a sentence which cannot stand alone, but depends upon some other sentence. A principal sen., etc.

The complex sentence. When a sentence contains both a principal and a subordinate sentence, the whole is called a complex sentence, as 'Men who are honest are happy.' Give a few other examples, children pointing out the principal and subordinate sentences.

Kinds of sub. sentences. If time permits, the three kinds of subordinate sentences may be noticed.

(*a*) The adj. sen. — In the sentence given above show that because 'who are honest' takes the place of an adjective it is called 'an adjective sentence.' Other examples.

(*b*) The noun sen. — Take another sentence, as 'The saying is true.' Change it into 'What they say is true,' and explain that 'What they say' is called a noun sentence, because it takes the place of a noun, viz., 'the saying.'

(*c*) The adverbial sen. — Take another sentence, as 'He came directly,' For 'directly' substitute 'when he was called,' and explain why it is an adverbial sentence. A few other examples will complete a full lesson.

2. Write out some of the chief principles to be observed in the lighting and ventilating of a schoolroom.

Lighting.—If possible, there should be two large windows at each end of the room, independently of side windows. The classes should be arranged so that the children do not sit in their own light. When gas is lit, the same care must be taken, the best place for the gas being generally down the centre of the room. The walls should not be painted white to reflect too much light.

Ventilation.—The windows should reach as near the ceiling as possible. There should be ventilators in the floor or near the ground. Care should be taken to avoid a draught, though a constant supply of fresh air is needed. No overcrowding should exist, and during the dinner-time the room should be thoroughly ventilated by opening doors and windows.

3. Point out some of the principal uses of a blackboard for teaching arithmetic, geography, and object lessons.

Arithmetic.—Working examples; setting down rules, and showing their reasons; to enable children to put down their sums neatly.

Geography.—For drawing sketch maps and diagrams; for summaries.

Object Lessons.—For illustrating by diagrams; for setting down chief facts taught; for recapitulation.

6. State how you would explain to a scholar in the third standard the value of the full remainder obtained in the division of 349 by 42 when the division is performed by the factors 6 and 7 *successively*.

We first divide by 6 to find how many sixes in 349, and we find that there are 58 sixes and a unit over.

We then divide by 7 to find how many sevens of these sixes there are, and we find that there are 8 sevens and two of these sixes over. Now the whole remainder is the two sixes and a unit, which is equal to 12+1, or 13, as shown in the example.

```
6)349
7) 58-1
   8 + 2 sixes + 1 =
   8 and 12 + 1 =
   8 and 13 over.
```

4. Name some of the subjects appropriate for home lessons, and give a sketch of a week's home lessons for scholars in the fourth standard.

Subjects appropriate for Home Lessons.—Examples in arithmetic; questions in geography or history; a short sentence to parse; spelling, with meanings to be written; maps, etc.

In giving home lessons I think it is a good plan to give one ex. in arithmetic every evening, together with a short exercise in some other subject.

A Week's Home Lessons.

Monday.	*Tuesday.*	*Wednesday.*	*Thursday*	*Friday.*
Arithmetic	Arithmetic	Arithmetic	Arithmetic	Arithmetic
Short sentence to parse.	Question in geog. or hist.	Words, with meanings.	Question in some lesson given during day.	Map

13. Distinguish the teaching of the rule of three by the method of unity and by proportion.

Take an example thus: If 4 men earn £20 in a certain time, how much would 10 men earn at the same rate?

Method of Unity.—We first write down the fact stated in the question, keeping the amount at the end of the line in the same name as the answer will be, thus:

	£
4 men earn	20
1 man earns	$\frac{20}{4}$
10 earn	$\frac{20 \times 10}{4} = 50$

We next take *one* of the other quantity, viz., men, and find what this one will earn, thus:

We now take the required number, thus:

In Proportion we find in what name the answer is to be, and then place the quantity of that name given us in the question, viz., £20, in what is called the third term of the proportion.

We now take the other two quantities, and compare their values, thus: as many times as 10 is greater than 4 will our answer be greater than 20, and put the three terms down, thus:

4 : 10 :: 20 : Ans

which means 4 is to 10 as 20 is to the answer. The answer is obtained by multiplying the 2nd and 3rd terms together and dividing by the 1st, thus:

£

$\frac{10 \times 20}{4} = 50.$

15. Give a brief sketch of a first lesson on the Adverb.

Introduction.—Write upon blackboard a short sentence as 'We walked.' Ask children to give words telling about 'walked.' Elicit such words as—quickly, slowly, onward, backward, yesterday, etc.

Definition of an adverb. — Now these words are added to the word walked. What part of speech is walked? Therefore these words are added to a verb, and are therefore called ad-verbs.

What does 'quickly' tell? (how); 'onward?' (where); yesterday? (when). Thus an adverb is a word that tells us how, when, and where actions are done.

Kinds of adverbs (three most common only). — What do we call the way in which a thing is done? (manner). Give few examples of adverbs of manner. Where it is done (place). Give examples. When it is done (time). Give examples. Take other similar sentences, and let boys arrange the adverbs in three columns, viz.: of time, place, and manner.

16. Write the words 'Geographical Analysis' in text hand, and give rules for the length of the letters *p*, *h*, *l*, and *y*.

Geographical Analysis.

Letter *p*. Above the line to about half the height by which the capital letter exceeds the other letters, and below the line to the whole of this distance.

" *h*. Above the line to the same height as the capital.

" *l*. The same as *h*.

" *y*. Below the line to a distance about equal to that by which *l* or the capital exceeds the other letters in height.

Geography and History.

1. Draw an outline map, with meridians and parallels, if you can, noting thereon the principal physical features of Italy.

2. Explain the following terms:—Meridian of Greenwich, Equatorial diameter, ecliptic, solstice, estuary, confluence, plateau.

Meridian of Greenwich.—The imaginary line drawn from Pole to Pole perpendicular to the Equator and passing through Greenwich. It is our first meridian of longitude, from which all others are reckoned E. or W.

Equatorial Diameter.—The diameter of the earth whose extremities are terminated by the Equator.

Ecliptic.—The path followed by the sun in its apparent annual motion. It is so called because eclipses take place when the moon is in this line.

Solstice.—The standing still of the sun caused by the sun reaching its northern or southern limit, viz.: the tropic of Cancer or Capricorn, when it turns again towards the Equator.

Estuary.—The opening worn by a river at its mouth.

Confluence.—A junction of two or more rivers.

Plateau.—An elevated plain or table-land.

3. Describe briefly in words the courses of the Ganges and the Nile.

The Ganges rises in the Himalayas, and flows south-east through the North-west Provinces and Bengal into the Bay of Bengal, which it enters by numerous mouths, the chief of which is called Hoogly. The swampy and low-lying district drained by the many mouths is called the Sunderbunds. It receives on the left the Gogra and Goomtee, and on the right the Jumna with the Chumbul. It passes the towns of Cawnpore, Allahabad, Benares, Patna, Moorshedabad, Dacca, Calcutta, Canning Town, and Chandernagore: on the Goomtee is Lucknow, and on the Jumna, Delhi and Agra.

The Nile is believed to rise in L. Tanganyika, from which it flows into the Victoria Nyanza; from this lake Sir Samuel Baker has traced it to L. Albert Nyanza, from which it issues and maintains a northward but winding course through Nubia and Egypt, falling to the level of the Mediterranean by a succession of cataracts and entering that sea by several mouths, after having traversed a distance of about 3,500 miles. It receives, on the right the Blue Nile and the Atbara with the Tacazze rom Abyssinia, while for the last 1,500 miles it receives no tributaries. The chief towns on its banks are Gondokoro, Khartoum, Shendy, Berber, Old and New Dongola, Derr, Assouan, Siout, Cairo, Rosetta, Damietta: on the Blue Nile is Senaar, and on the Atbara Gondar.

6. Give some account of the Soudan, Manitoba, and Ceylon.

The Soudan is a vast territory consisting of many independent states, stretching across Africa from Senegambia to Nubia. It is peopled chiefly by negroes, hence its name Nigritia, but in the east are many Arabs. Several of the states are flourishing, the chief occupations of the people being caravan trading, agriculture, and cattle-rearing, with a few rude manufactures and working in metals. Its chief towns are Soccatoo, the largest, and capital of Howsa; Timbuctoo, great caravan trade; Sego on Niger, and Boussa on same river, where Sir Mungo Park was drowned. The eastern part is, and has been for some time, in a state of great commotion and warfare, on account of the rise of the Mahdi or false Mahometan prophet.

Manitoba, or Red River Settlement, is situated about half way between Canada and the Rocky Mountains. It is inhabited by colonists and Indians, the former of whom are engaged in clearing the ground, the timber trade, and agriculture, whilst the latter live chiefly by hunting. The soil is rich and fertile, being either covered with forest trees or prairie land. The capital is Fort Garry.

Ceylon is the pear-shaped island lying off the south of India. The soil is fertile, and the island is very famous for the quantity and quality ot its spices, especially cinnamon. In the centre is a mountain, called Adam's Peak, and stretching across the Palk's Straits is a line of sandbanks, termed Adam's Bridge. Its chief towns are Kandy, the former capital; Colombo, the present capital; Point de Galle, a seaport, at which steamers touch on the way to Australia; and Trincomalee, a seaport on the east of the island.

7. Enumerate the chief productions of British North America, Queensland, and Jamaica.

British North America.—Timber (chiefly pine), wheat and other cereals, flax, hemp, tobacco; gold, coal, iron, and petroleum, or mineral oil; cattle, furs; fish (chiefly cod), sealskin, and produce of whale fishery.

Queensland.—Wool, cocoanut, and other palms in the tropical part, wheat and other cereals; sugar and cotton, but not to a very great extent; gold, coal, and iron.

Jamaica.—Sugar, rum, cotton, coffee, cocoa, spices, ginger, tobacco, mahogany, logwood, cocoanut, manioc, bread-fruit, etc.

History.

8. Arrange in chronological order, and give the dates of the following events:—The discovery of America; the battles of the Nile, Flodden, Bannockburn, and Marston Moor; the accession of Stephen, Anne, and Elizabeth; the Act of Habeas Corpus and of Slave Emancipation; the death of Becket, of Charles I., and Simon de Monfort.

Accession of Stephen, 1135; death of Becket, 1170; death of Simon de Monfort, 1265; battle of Bannockburn, 1314; discovery of America, 1492; battle of Flodden Field, 1513; accession of Elizabeth, 1558: battle of Marston Moor, 1644; death of Charles I., 1649; Habeas Corpus Act, 1679; accession of Anne, 1702; battle of Nile, 1798; Slave Emancipation Bill, 1833.

10. Explain the terms—Alderman, Magna Charta, feudal system, and viceroy.

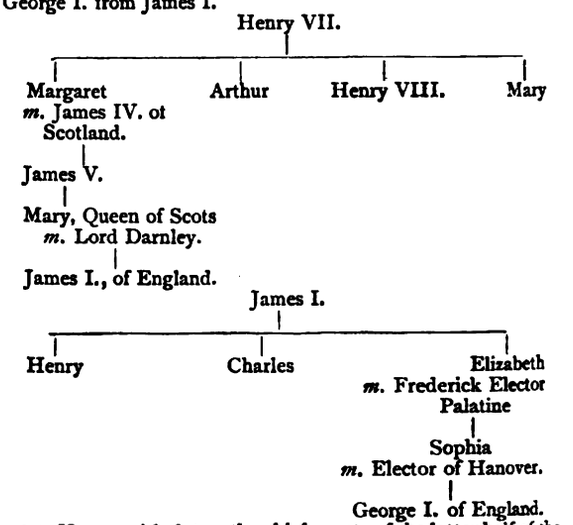
Alderman or Earl was originally the title of the old Saxon nobility; they formed the highest class of freemen, and ranked next to the king, after whom they were the principal members of the Witenagemote. They generally held a portion of land termed a shire, which it was their duty to govern. In the Norman times the terms alderman and shire were superseded by count and county.

The Magna Charta, or Great Charter of 1215, is generally regarded as the foundation of English liberty. Owing to the arbitrary and intolerable conduct of John, the barons of England drew up this code of laws, and calling a great meeting presented it to their sovereign at Runnymede, where the worthless monarch was compelled to sign it. Its chief provisions were:—1. That no freeman should be imprisoned, outlawed, etc., but by the judgment of his peers and by the law of the land. 2. That justice should be delayed or denied to no man. 3. That no taxes should be levied but by the consent of the Great Council, excepting on these occasions, viz., the knighting of king's eldest son, the marrying of his eldest daughter, and the ransom of the king's person. There were many other minor provisions granting further liberties to all classes of men.

The feudal system was that system of government in which the king let out the land to the barons, while the barons again let out their portions to their vassals. Instead of paying a rent, however, these vassals were obliged to furnish food for their lord's table, and to do him military service whenever required, the baron himself being bound to do the same service to the king. By this means the king could always command a large army.

Viceroy.—This word comes to us from the French: its meaning is instead of a king; thus a viceroy is a ruler appointed instead of a sovereign, whose representative he is.

12. Trace the descent of James I. from Henry VII., and of George I. from James I.



15. Name, with dates, the chief events of the latter half of the eighteenth century.

1752. Alteration of the Calendar.
1756. Seven Years' War commenced. French took Minorca.
1757. Pitt's first ministry. Battle of Plassey.
1759. Quebec taken: death of Wolfe.
1760. Conquest of Canada. Death of George II. Accession of George III.
1763. Grenville's ministry. Prosecution of Wilkes.
1765. American Stamp Act.
1771. Debates of the House first published.
1775. American War, Bunkers' Hill.
1776. American declaration of Independence.
1777. Battle of Brandywine.
1778. Surrender of Burgoyne at Saratoga.
1779. Siege of Gibraltar.
1781. Surrender of Lord Cornwallis at York Town.
1783. Treaty of Versailles.
1793. War with French Republic.
1794. Lord Howe defeated French fleet off Cape Ushant.
1795. Capture of Ceylon and Cape Colony.
1797. Jervis and Nelson defeated Spanish fleet off Cape St. Vincent.
1797. Dutch fleet defeated by Duncan off Camperdown.
1798. Battle of the Nile.
1798. Irish Rebellion. Vinegar Hill.
1799. Wellesley at Seringapatam.
1801. French defeated by Abercrombie at Alexandria.

(To be continued.)

Passing farther into the park, we come to a wide, open space, nicely rolled and mowed, in which we see there is something very important going on. Getting closer, we find that it is a cricket match between the Board school and Mr. Henton's school. See how eager the onlookers are! The fact is, there is a friendly, but keen, rivalry existing between the two schools, and this match has been looked forward to for some weeks past with the most intense anxiety. We seem to remember that stalwart man who is standing umpire at the farther wicket, and at once recognise our old friend, Mr. Stafford. Harrison, who is going to college, if successful, next Christmas, is umpire at this end.

Schoolboy cricket is not generally interesting to those who thoroughly understand the game, except that they are glad to see boys engaged in such manly, healthy exercise. As is evident in the present game, it is one of great enjoyment to the youngsters, both those who are playing and those who are looking on from all parts of the field, reclining in every imaginable attitude.

The Voluntary boys at present seem to be having the best of it, for they are hitting the bowling all over the field. At last, they are all out for 80—a very decent score. The Board boys—Mr. Stafford's, it will be remembered—do not look much like those we found him teaching when we first became acquainted with him. They do not keep us long waiting, like a good many of their elders are fond of doing, between the innings, but send out their two first *men* to the wickets.

They start badly, for both are out with the score at 2. Altogether the eleven compile 52 runs between them. In Mr. Henton's boys' next venture they only put together 36 runs, leaving the Board boys 65 runs to get to win. They, however, failed to do this, the last wicket falling with the score at 51, leaving the Voluntary boys winners by 13 runs.

By the time this is finished four o'clock has arrived, and the children are gathering together from all parts of the park, which has been very kindly thrown open to both schools by the owner, the Chairman of the School Board, a gentleman who takes the greatest interest in education, and who likes to see children enjoy themselves.

He is now conversing with Mr. Henton and Miss Danford; and Mr. Stafford, released from his important duties in the cricket field, has just joined the group. Mr. Hawthorne is a gentleman in the prime of life, whose face shows the kindliness of his heart. He is one of those genial men who can talk to men in a subordinate position in the most friendly manner, without losing any of the dignity some *gentlemen* think must be guarded by an abrupt, haughty demeanour.

When the children are assembled, tea is served out to them, after which Mr. Hawthorne and other friends of both schools offer rewards for racing, jumping, etc. These are keenly competed for by boys and girls. This completes the day's amusements.

CHAPTER VIII.—FURTHER IMPROVEMENTS.

THE School Board in this little town are at all events to be congratulated on the health of the children, as compared with the state we found it in at the commencement of our story. There is no longer that listlessness and languor observable in the playground; all seem to enjoy themselves to the utmost. But, remembering the maxim that "cleanliness is next to godliness," they have done everything in their power to encourage bathing.

A part of the river has been fenced off, and a proper person has been appointed to take charge of the place, and to teach the boys that most necessary accomplishment, swimming. The children are, in most cases, only too willing to learn. Of course, there are some parents who object to this, as is always the case with anything beneficial. They do not, having never learnt themselves, see the use of it, or else they are afraid of their precious treasures taking cold.

Besides the benefit to be derived from the practice of swimming, what is there to compare with the feelings of a man who has been able to save a fellow creature from drowning? Then, as to the benefit derived by the children—it helps to keep open the pores of the skin, thus allowing the function of perspiration to be properly carried on. A child who does not, by washing, remove the worn-out cells of the skin, is more likely to fall under the attack of infectious disease. One who is not afraid of the sudden plunge on a summer morning into the cool stream is less likely to catch cold or fever from a sudden drenching in a storm, or an immersion from the capsizing of a boat.

(To be continued.)

Matriculation Hints.

BY HENRY A. REATCHLOUS, M.A. (LOND.), B.Sc.,
Westminster Training College.

THE use of the hygrometer seems to be included in the course in Natural Philosophy. There is always a certain amount of aqueous vapour present in the atmosphere. We can determine how many grams of water there are in a given number of litres of air, by drawing the moist air through drying tubes by means of an aspirator, and weighing the tubes after. The difference of weight would be the weight of water present; the quantity of water which passes through the aspirator measures the air which has been dried.

But it is not so much the absolute quantity of moisture present, as the ratio of this to the quantity which would saturate the air at the given temperature, that we have to find. This ratio is called the hygrometric state of the air. To determine it, we have to use a hygrometer, and consult a table of vapour pressures. We will give directions how to make a Regnault's hygrometer, how to use it, and then how to find the hygrometric state of the air. Order a thin boiling-tube to have a copper cap, about an inch long, fitted on the end of it and silvered. If the student is accustomed to silvering he can do that himself. Now fit the boiling-tube with a cork with three holes. Into one insert a thin thermometer; into the two others pieces of glass tubing, one dipping nearly to the bottom, the other just below the cork. Connect the long tube with an aspirator. This can be made out of a Winchester or a wash bottle. But an earthenware jar, in the shape of a filter, does much better, a small tap being inserted at the bottom. Fix the hygrometer in a clip-stand, pour some ether into the tube, and fill the aspirator with water. Take the temperature of the room; say it is 15°C. Now turn the tap, and as the air bubbles through the ether, its temperature gradually falls, till it reaches a point at which the air immediately surrounding it is completely saturated. This is the dew-point. As soon as the silver looks dull, the temperature is taken. It is well to take it again as soon as it appears bright again, and then call the average of these the dew-point.

Having found the dew-point, we get the hygrometric state thus:—Turn to a table of vapour pressures; there is one at the end of Stewart's 'Heat.' Look at the number opposite 15° C., or 60° F.—it is .5178.

Suppose the dew-point is 10° C., or 50 F., the number opposite this is .3607.

And the hygrometric state is the ratio $\frac{3607}{5178} = .69$.

If we use a Daniell's or a Dine's hygrometer, the method is the same; first find the dew-point, and then refer to the vapour pressures corresponding to the

actual temperature of the air and that of the dew-point, and the ratio of the second to the first is the hygrometric state.

Gases and liquids are both fluids. Gases are distinguishable by compressibility and by their tendency to expand indefinitely. Boyle's law and its applications should be studied. If V be the volume, and P the pressure, of a given mass of a gas, the product VP will be a constant quantity, every change in V involving a corresponding change in P. Instruments for measuring the pressure of gases or vapours are called manometers. A U-tube, with a little mercury in it, illustrates the principle of one of them; one end of it can be attached to the gas supply, and the difference of level observed. Suppose the barometer stands at 76 cm. This corresponds to 1033 gms. per sq. cm.; a difference of 2 cm. would, therefore, imply a pressure of $\frac{1033 \times 2}{76} = 27$ gms. per sq. cm.

The fact that air has weight can be easily demonstrated, even with an ordinary balance. Expel the air from a flask by boiling a little water in it; when the steam is escaping vigorously, close up the end. Let it cool, and then counterpoise; now allow air to enter. The increased weight of the flask will be at once apparent. If there is an air-pump at hand, a globe can be weighed before and after exhaustion.

Much simpler methods of finding the weights of a litre of air and other gases than have hitherto been thought practicable are to be found in the little work by Dr. Ramsey, called 'Experimental Proofs of Chemical Theory.'

What is called the Torricellian experiment should be thoroughly understood. The height of the mercurial column indicates the pressure of the atmosphere at the place of the experiment. If it is 76 cm., the weight on a sq. cm. is $76 \times 13{\cdot}6 = 1033$ gms. This is equivalent to $1033 \times 981 = 1{,}013{,}667$ dynes per sq. cm. Notice that the atmospheric pressure in the case above, 1,013,667 dynes per sq. cm., divided by the specific gravity of mercury and the force of gravity at the spot, gives us the height of the mercurial column $\frac{1013667}{13{\cdot}6 \times 981} = 76$. We could find the height of a column of any other liquid by substituting its specific gravity for 13·6; thus, for water it would be $76 \times 13{\cdot}6 = 1033{\cdot}6$ cm. = nearly 33 feet.

If a little water be allowed to enter the tube with the mercury, some of it will be vapour in the upper part of the tube and depressed column of mercury. The exact amount of the vapour pressure will depend upon the temperature, and can be found, by reference to a table, in grams per sq. cm. This pressure remains constant so long as the temperature does not alter, whether the tube be raised or lowered, provided there is always a little water not vaporised.

If, instead of a small quantity of a liquid, some air or any other gas should enter the tube, there will be a depression of the mercury, but the amount of depression will vary with the space occupied by the gas. Boyle's law applies to gases, but not to saturated vapours.

Archimedes' principle applies to gases as well as liquids. It is owing to this that balloons rise. They will ascend so long as their weight is less than that of the air displaced by them. The syllabus specially names the barometer, syphon, common pump, forcing-pump, and air-pump; these are all fully described in the manuals in common use. The main thing in regard to the atmospheric pressure is to know how to estimate it and express it. The old way, stating it in lbs. on the in sq. inch, should be discarded. For scientific if not for general purposes, the metric system is sure to be ultimately adopted, perhaps before very long. And pressures should be expressed in dynes per sq. cm., in preference to grams; because grams, like lbs., do not bring out the fact that it is gravity, not less than the matter contained in a body, that determines its weight. The pressure of a lb. on the sq. inch is not the same on the top of a mountain as it is at the bottom of a coal mine, whereas its apparent equivalent—69,000 dynes per sq. cm.—is the same everywhere.

(To be continued.)

—o—

Publications Received.

Blackie and Son—
Vere Foster's Painting for Beginners. In 9 parts.
Trees in Pencil and Colour. By J. Needham. In 8 parts.
Miss Fenwick's Failures. By Esmé Stuart.
Winnie's Secret. By Kate Wood.
Down and Up Again. By Gregson Gow.
Warner's Chace. By A. S. Swan.

Chambers (W. and R.)—
Object Lessons. By C. McRae, M.A.

Crosby Lockwood and Co.—
The Compendious Calculator. By D. O'Gorman.

Derfel (R. J.)—
Science Simplified for Little Ones. By M. H. Senior.

Educational Supply Association—
The E.S.A.'s Test Cards. Standards II. to VII.
The Holborn Series of Poetry Books. Shakspere's King John, Mrs. Hemans, Byron, Longfellow, and Selections of Poetry.

Hickmans (D.)—
The Practical Register of Attendance and Fees. By W. J. Binns and D. Hickmans.

Hodder and Stoughton—
Andrew Marvel and his Friends. By Marie Hall.
The Children of China.
Economical Cookery. By Mrs. Addison.

Jarrold and Sons—
Free England. By H. E. B.
A Star in the Crown. By D. Darlinghurst.
The Teachers' Diary and Pocket Book, 1885.

Laurie (T.)—
A Grammar for Beginners. By E. Bartrop.
Kensington Table Cards.
The Graduated Arithmetic. Parts 1, 2, and 3, and Book of Answers.

Letts, Son, and Co.—
Letts's Household Magazine. December.

Longmans and Co.—
Johnston's Intermediate and General Geography.

Miscellaneous—
Second Annual Report of the Metropolitan Public Garden, Boulevard, and Playground Association, 1884.

Murby (T.)—
Murby's Excelsior Reading Books. Nos. 1 and 2.

Murray (John)—
Little Arthur's France.

Smith, Elder, and Co.—
The Cornhill Magazine. December.

Stock (Elliot)—
Experimentum Brevissimum. By H. T. M. Horne.

Swann Sonnenschein and Co.—
Scientific Romances. No. 1. By C. H. Hinton, B.A.
Systematic Cutting-out. By E. M. Brant.
Notes on Early Training of Children. By Mrs. F. Malleson.

Symons and Co.—
Meister Martin—German Classics.

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Portfolios, fitted with elastic bands, for preserving twelve numbers of 'The Practical Teacher,' may now be had. Price 2s. 6d. Orders should be given through booksellers.

The numbers of the *Practical Teacher* for February and March, 1884, are now out of print.

Publications Reviewed.

Shakespeare's Plays for Schools. Abridged and Annotated. By Charlotte M. Yonge. 'King Richard II.' London: National Society's Depository.

'King Richard II.' is one of Shakespeare's plays that for young readers needs least abridgment, and is one of those that need most annotation. The abridgment of Miss Yonge is, therefore, on the smallest scale. As far as we can see, she has only taken out the following passages:—Five lines in Richard's long speech to the rebellious and recalcitrant Mowbray and Hereford, after his indecisive action in preventing their necessary combat; eleven lines in Act II. scene 2., just before the entry of York; eight or nine in Act V. scene 2, one of which is in the middle of the speech of the Duchess of York beginning—

'Why, York, what wilt thou do?'

and the rest just before the exit of her husband; one more is cut out in the next scene.

As to these omissions they are almost all necessary for young readers. But the five in Richard's long speech might fairly, both to Shakespeare and to the student, be retained. They comprise two of the sweetest lines in the play—

'To wake our peace, which in our country's cradle
Draws the sweet infant breath of gentle sleep'—

lines of the more value as they have a faint ante-taste of the Macbeth line—

'Whom we to seek our peace have sent to peace'—

and will come back to the Shakespearean when the latter stronger line is read. The eleven lines in II. 2, must go; and so must the lines omitted in V. 2, and the line in V. 3. But we are not sure that Miss Yonge would not have exercised a wiser discretion in excising yet more at large the Duchess of York scene. This is doubtfully Shakespeare's, and is neither good English nor good play-writing.

The annotation is done well; the introduction is excellent; so is the summary of the play; so is the expansion of the list *dramatis personarum*: so are the notes and paraphrases—though a little carelessness in the matter of composition has led Miss Yonge to say that which we are sure she had not intended to say. The note on 'lewd' has the rather ambiguous phrase—'"lay" or "laity," in distinction to the clergy, and, as these were unlearned, lewd meant first ignorant, then wicked.' Nor is the unintentional slur on the clergy thus cast, in default of good English, atoned by a reference at the end of the note to Acts xvii. 5. The notes drop off fitfully towards the end of the play, but they are good, nevertheless.

Practical Help for Infants' Teachers. By James E. Singleton. London: Jarrold and Sons.

This is the work of a practical teacher, who is now engaged in the more responsible, and not less arduous, duty of examination and inspection.

The 'Methods of Instruction,' in Part II., exhibit intimate knowledge of the Code requirements and fertility of resource in meeting them. Infant-teachers are anxious for guidance in the new features of the Mundella Code, viz., the choice of a suitable series of object lessons, and the so-called 'varied occupations.' Mr. Singleton has already issued books on these topics. In the present volume most space is given to modes of teaching the 'three R's.' The method suggested for instruction in the early stages of reading is excellent; the alphabet is made attractive by processes of comparison and contrast afforded by the letter forms; experience and sound reason have combined to select reading and transcription for the most effective modes of teaching English spelling; number is made entirely dependent upon an abundance of concrete examples; the selection of object lessons affords sufficient variety of topics to awaken the interest, and stimulate the observation, of young children; at the same time sufficient connection runs through the subjects to exercise children in the valuable effort of grouping the knowledge imparted.

In Part I. the author attempts to state the principles of mental science upon which the various methods employed rest. We cannot give this portion of the book unqualified approval.

In the historical sketch of the several phases of a

schoolboy's career the incidents have been skilfully arranged and graphically stated. The paraphrases of Lesson III. into language suitable for the infant-school are particularly good. Indeed, the entire story, with its moral applications, might with advantage have been stated in the same simple and forcible language.

Chemistry Wall Sheets; Sheets I. and II. Edinburgh and London: W. and A. K. Johnston.

The above two large wall sheets will, if we mistake not, prove welcome accessories in the class rooms of teachers of elementary science.

Sheet I. is a clearly-printed and well-arranged tabulated statement of those substances which are at present classed as elementary, giving their symbols, atomic weights, and quantivalence. A noticeable feature, which distinguishes this sheet to some extent from other lists which have come under our notice, lies in the fact that the names of the more common and important elements are printed on a pink ground, and those of a rarer nature or of less importance on a blue.

Sheet II. deals with those features of natural science of which a due appreciation is necessary as introductory to the study of chemistry. Commencing with diagrams illustrative of Cavendish's experiments on attraction, there follow equally clear explanatory drawings of cohesion, capillarity, specific gravity, osmose and diffusion of liquids and gases, etc.

The handbooks supplied with the sheets are lucidly written, and supply abundant information, not only for intelligibly understanding the various plates, but also for obtaining a wider insight into the subject-matter.

Natural History Plates. Edinburgh and London: W. and A. K. Johnston.

Teachers will welcome these remarkably effective illustrations of animal life. Those we have personally inspected leave little to be desired either in accuracy of drawing or effectiveness of colouring. They are of fair size, and of bold design, and are thus well adapted for use with large classes.

Types of Nations. A Series of Wall Sheets. Edinburgh and London: W. and A. K. Johnston.

It would be hardly possible for young people to acquire a clear idea of the personal appearance and dress of the inhabitants of foreign lands were not some assistance of a pictorial nature afforded them. Judging from the two or three specimens we have seen of the above series, the illustrations therein given to supply this want seem exactly to meet the requirements of the case. As a rule the accessories in the pictures are made to convey as extended an idea as possible not only of the appearance and dress of the people represented, but also of their customs, and the natural productions of the country they inhabit. An exception, however, is to some extent made in the case of the Chinese; for, oddly enough, the drawing illustrative of that peculiar race contains no allusion to two facts peculiarly typical of them—the use of their natural beverage—tea, and the custom prevalent amongst ladies of the higher classes of cramping their feet into tiny triangular shoe-lets.

Object-Lesson Pictures for Schools: Fruit Trees. London: A. Johnston.

This series of coloured illustrations is uniform with the Useful Plant series emanating from the same publisher, and is equally deserving of praise. The size is a serviceable one—25 inches by 20, being neither too large for portability, nor too small for general class use. The drawings are clear and effective in colouring and design, and they will undoubtedly prove useful and instructive adjuncts in connection with the giving of object lessons.

First Natural History Reader. For Standard II. According to the requirements of the Revised Code. Quadrupeds and Birds. London: Marshall, Japp and Co.

To paraphrase Portia's line—'The code requires it, and the publishers give it.' This is the expression of the *raison d'être* of legions of books that would not otherwise have seen the light of children's eyes beating upon them. The 'requirements of the revised code' also lead to the use of the name 'natural history,' not in its original sense of an account of natural phenomena generally, but in its limited sense as an account of zoological phenomena particularly.

The same 'requirements' are, doubtless, responsible for the bad order in which the various animals are discussed in this volume. Not only are the quadrupeds studied before the birds, that is the higher class before the lower, but a like misplacement is observable in dealing with the Primates. The order is, to use a commonplace phrase, 'neither one thing nor the other.' Thus the monkeys are taken first, then the apes, which are higher than the monkeys, then the long-tailed monkeys, lower than the monkeys.

Of general criticism, only one or two points present themselves. Is it quite wise to refer to 'hundred weights' in a book for Standard II., or to speak of 'camel's-hair pencils' without explaining that a 'pencil' is a brush? We could wish also that a question that, in our youth, vexed us sorely had been solved for the present generation that rises. This is the question of the difference between the crow and the rook, a difference easily pointed out to young students.

Turning to special criticism, there are scarcely any actual blunders in the book. Seeing that the order Bimana is now an exploded one, and that the name Primates is used preferably to that of Quadrumana for the highest order of the class Mammalia, the order including man, apes, and monkeys, we think it is unadvisable to speak of the last-named as 'four-handed animals' (p. 2), in contra-distinction to man as a two-handed Primate. The dentine of the teeth (p. 37) is not soft bone. As these are the only scientific points that we can subject to adverse criticism, it will be gathered that the science part of the work is well done.

We wish we could say the same for the literary side of the book. The English is not all that is desirable. Change of tense, as on page 4, 'will' for 'shall' (p. 9), inelegancies like 'on next page' (p. 17), tusks 'as *large* as fourteen feet *long*' (p. 28), 'only the front of these four teeth are coated' (p. 37), are instances. The *bête-noir* of the average writer, 'which,' haunts the author of the Natural History Reader. Pages 13 and 69 are in evidence. 'They have toes of a peculiar form which enables them to do this.' And that vagueness in the use of pronouns that seems to be a fatality with writers on elementary science is also to the fore. Pages 6, 10, 20, may be mentioned, and on page 48 we have three sentences running thus: 'The strong claws aid *it* to dig . . . in search of ants and other insects on which *they* feed. *They* are very swift. . . The American Indians esteem *it*.'

Occasionally a little ambiguity is noticeable. It is not quite clear, *e.g.*, how the camel's hump serves as food to the camel (p. 30). An imaginative child might think that the camel actually turned its head round and browsed, so to speak, upon its own back. Nor are the alveolar cavities in the camel's stomach described very clearly. And the following expressions are somewhat open to misconstruction: 'The kingfisher has a beak like the bee-eater, but it is quite straight and four-sided. Its legs are short.' 'People keep fowls because they lay plenty of eggs.'

The writer might, without making his work over-difficult, have touched lightly on homologies. That a bird's wing is a modified arm, that in the short neck of the elephant or of the whale there are as many bones as in the long one of the giraffe, that feathers and hairs are of kindred nature are truths not too deep for children and

are ideas that would lead them early, as they should be led, to the observation of unity of structure. The omission is the more noticeable as on pages 18, 22, the writer has taught without any undue forcing the doctrine of colour-mimicry in animals.

The moral teaching is introduced unobtrusively and even delicately (see p. 21), though we regret that the accounts of man's cruelty to the lower animals are given without a word of pity. The cruelty may be 'necessary' (in the opinion of man). Nevertheless the account of whale-hunting (p. 23), and of deer-stalking (p. 37), would bear as supplement some passing expression of regret at least.

Wall Map of Palestine. London and Edinburgh: W. and A. K. Johnston.

This wall map is well designed to suit the uses for which it is intended. The positions of the various places are marked clearly and judiciously, so that, while the map contains all the places necessary for even the advanced Bible student, there is no appearance of crowding, and the legibility is in no way interfered with. The map is divided longitudinally into two portions, that on the left representing Palestine in Old Testament days, that on the right in the time of the New. There are also two subsidiary maps illustrating the city of Jerusalem and the district in its immediate vicinity.

Without in any way reflecting on native talent in the matter of map-producing, we would venture however to express a hope that the lessons conveyed by the display of Continental school maps at the recently closed Health Exhibition may not be without their effect, and that some of the really excellent productions there shown may furnish British map-makers with a hint or two of which they will not be slow to avail themselves. One physical map of Europe—in the French exhibit, if we remember aright—seemed to us particularly happy and effective for school use. The sea, lakes, and rivers were of a bright turquoise blue; the land of a warm brown, graduating into lighter shades and into pure white as higher levels were reached. The configuration of the mountain chains was plainly marked by appropriate light and shade, and an effect was obtained very similar to a raised map with a strong light thrown diagonally across it. The rugged ranges of Central Europe, and the wide plains of Russia and North Germany were equally well exhibited by this plan of colouring, and the effect of the map altogether was such as to emphasize and bring into remarkably clear contra-distinction the divisions of land and water, and the varying levels of the land-surface.

John Wicliffe, the Morning Star of the Reformation. By David J. Deane. London: S. W. Partridge and Co.

The quincentenary of this Reformer and patriot occurring this year has brought his name prominently before the public. Mr. Deane tells the story of Wicliffe's life in a pleasant, unbiassed fashion. We are inclined to think that sufficient credit has hardly been given to the Reformer for his exertions in the cause of freedom, and we are glad to notice the prominence which is given to that part of Wicliffe's work by the author. To those who have not leisure to examine larger works this 'Life' can be heartily recommended.

Chambers's Graduated Readers. Book V. London and Edinburgh: W. and R. Chambers.

This book maintains the character of the series of which it forms a part. It consists entirely of extracts from standard authors, and the selection is one which meets with our entire approval. There is not an unsuitable piece in the whole book, nor one which is beyond the capacity of the children for whom the book is intended. A short introduction is given to each selection, and the addition of a list of words and word-building exercises adds greatly to the educational value of the book.

Readings from Sir Walter Scott. London: Blackie and Son, 49 and 50, Old Bailey.

If the schoolboy of the present day does not acquire a taste for the best literature in the English language, it will not be for want of opportunities of becoming acquainted with it. Messrs. Blackie and Son here present us with a selection of connected stories from the 'Wizard of the North.' The book is thoroughly well-suited for a reading-book. Besides extracts from *The Talisman*, *Ivanhoe*, *Anne of Geierstein*, and *Marmion*, it has a biographical sketch of the author, explanations of words and allusions in the text, a list of words derived from Latin, with their roots, and the Latin prefixes. It is strongly bound and well printed, and is issued at a reasonable price.

Geographical Reading-Books.—The British Islands. By Thomas Parry, F.R.G.S. London: Longmans, Green and Co.

The respected author of this reading-book passed away before it issued from the press. He was a practical teacher, of proved ability, and the pages show the skill which he could display in arranging and presenting useful information. The book, however, while suitable as a reading-book, does not cover the ground required by the Code. It contains more than is required for Standard III., and less than is expected from Standard IV. Where a teacher chooses his own course of lessons, and adopts a method of division different from that commonly selected, the book can be used with profit; but as geography is supposed to be taught now from reading-books, a teacher who selects this book for either of the standards named, expecting to find its contents suitable for the Code, will be disappointed.

The Queen and Her Relations. London: Henry G. Davies, 73, Ludgate Hill.

A sheet containing a table of the descendants of George III., another of the Danish Royal Family, and a third of the descent of Her Majesty from Alfred the Great, is thus named. It is more complete than the tables usually found in histories, and, to any one wishing to know the number and the connections of the present Royal Family, will be very handy.

The Young England School Series.—Geographies. Standards I. to VII. By S. B. Tait. London: Jarrold and Sons, 3, Paternoster Buildings.

Teachers who use the Empire Series of Home Lesson Books will at once recognise these six little books as reprints of the geography lessons in that series. They are well printed, though the type is somewhat small; and can be used as memory-books with any set of geographical readers. The information is correct, concise, and full. From twenty to fifty Inspectors' Questions are given with each book.

Arithmetic. Standards I. to VII. London: Jarrold and Sons, 3, Paternoster Buildings.

Like the preceding books, these are also reprints, with additions, from the Home Lesson Books named. The examples are well graduated, and contain many specimens of Inspectors' Sums. The type, however, is much too small, although the printing is good.

Daisy Snowflake's Secret. By Mrs. G. S. Reaney. London: Hodder and Stoughton.

Mrs. Reaney in this volume traces the history of an orphan placed among relatives in a well-to-do family, whose life was overshadowed by the necessity for keeping secret the habit of intemperance into which her aunt had fallen. The story is simply and naturally told, and deals with a phase of home life which we are sorry to believe

is much more common than formerly. We heartily wish for the book a wide circulation, assured that its influence will be for good, although we find it difficult to bring ourselves to believe that there are many medical men who have deliberately come to the conclusion that they must refuse to give up sanctioning the use of intoxicants simply because it 'would not pay.'

The Eclipse Arithmetical Test Cards. Standards II. to VII. London: The Educational Supply Association (Limited), Holborn Viaduct.

These cards have the manifest advantages of good printing, stout cards, and strong cases. There are twenty-eight test cards, and a card of answers in each packet. Each card has eight sums, divided into two sets of four each, thus serving as a double test for two different periods of the year. The problems are very good, but are somewhat difficult in the Fourth Standard. The set supplied to us contains four imperfectly cut cards in the Fifth Standard, and two sets of Standard VII cards have been sent instead of one each of Standards VI. and VII.

Akrill's Arithmetical and Spelling Cards. Standards I. to VII. Lincoln: Charles Akrill, 253, High Street.

This set comprises seven packets of extra-stout well-printed cards, compiled to answer the purpose of test cards in arithmetic, and of supplying spelling exercises as well. The sums have been well constructed, and a novel feature of the cards is that of printing the word denoting the requirement of the sum in bolder type.

The spellings have been so arranged as to give words of one syllable to the First Standard, two to the Second, and so on, apparently without any regard to the suitability of the words otherwise. This leads to some strange requirements from young children, such as *rheum*, *pshaw*, *newt*, *lymph*, and *quartz* for Standard I.; *catarrh*, *epergne*, *façade*, *phthisis*, and *poignant* for Standard II.; *æsthetic*, *coalesce*, *rendezvous*, *surveillance*, for Standard III.; and other equally unsuitable words for Standards IV. and V. Standards VI. and VII. have Latin prefixes and roots respectively, with examples and meanings.

The Practical Register of Attendance and Fees. By W. J. Binns and D. Hickmans. London: John Marshall and Co., 42, Paternoster Row.

The *Practical Register* is very well printed, on good paper, and in a stout cover, strengthened by a band of cloth up the back. The four principal openings each contain spaces for fifty-five names, with the various particulars necessary for fees and attendances only. There is no fly-leaf. The compilers state that their chief aim has been to save the time of teachers, and to avoid all unnecessary labour. To this end they devote the first two pages to what they call the 'essential requirements of a Register.' By the use of these pages such entries as 'Admission No., Date of Admission, Date of Birth, and Last Standard,' are required to be written once only.

In these particulars the *Register* fulfils the aims of the compilers.

A direction at the head of these pages says that names should be arranged alphabetically. It would have been well if a direction had also been given *how* to do this after the commencement of the school year, especially in schools where the number admitted is often equal to the number on the register. A supplement to the Admission Register in the shape of columns for 'Parents' Name,' and 'Last School,' to be used for admissions during the year, is a doubtful way of saving teachers' time. In districts, too, where children are migratory, a column for residence is necessary at each opening of the register; changes of residence being so frequent, that a space for a new address is absolutely needed. In country districts and small towns, this, of course, does not apply, and even in towns, the columns 'Parents' Name' and 'Last School' could be utilised for changes. We have not yet seen a perfect register, but the *Practical Register* comes as near perfection as any hitherto published, and teachers anxious to get one well-suited to different classes of schools might 'go further and fare worse.'

Higher Education in Germany and England. By Charles Bird. London: Kegan Paul and Co.

An admirable little book, whose issue just now shows the astuteness of the eminent publishing firm under whose auspices it sees the light. The compiler—Mr. Bird would be the first to claim this more modest title in preference to that of author—has done good work well. Almost nothing occurs in this volume to which even that hypercritic, the reviewer of books on education, can take exception. There may be a hint that Mr. Bird is not without an eye to future inspection of his own school, or possibly even to future inspectorships, and there certainly are one or two examples of English that Mr. Bird would not commend in others, and that we cannot in him. It may be urged that his German studies have, in some measure, impaired his English, or that the head-master of a mathematical, need not be so particular as the principal of a grammar, school. Nevertheless, 'Most people have a vague idea that they are somewhat ahead of us abroad in their educational arrangements' (page 5), and 'Geometry, and parallel with it geometrical drawing . . . begins,' are not, as sentences, all that they might be.

Another grumble may be not unfairly directed against Mr. Bird's want of system in the treatment of one part of his subject. This want is the more noticeable as it is itself, for the most part, wanting. For example, all the account of the time devoted to particular subjects in the various grades of German schools and of the topics and books considered under each subject is thoroughly systematic. The one part of the account of the educational arrangements in Germany that is not quite clearly marked out is the classification of the different kinds of schools.

The list of schools now to be given has to be compiled from pages 9, 31, 81, 88, 91. At the very outset, as we think, for the English reader a list of the establishments to be found in such a town as Stuttgart ought to have been given. These are from below upwards (1) The Volkschule (people's school)—our public elementary school; (2) The Burgerschule (citizen school)—our middle-class school; (3) The Realschule, or scientific school; (4) The Realgymnasium, half scientific, half classical school; (5) The Gymnasium, or classical school. All the three last have no exact parallel in England, but they are all higher grade schools. (6) The Polytechnic, a university for the Realschule pupils, as (7) The universities are for those of the Gymnasium; (8) The Fortbildungschule—our mechanics' institute; (9) The Baugewerkeschule, or technical school; (10) The Kunstgewerkeschule, or art school. It should be noted here that the system of schools is not as uniform throughout Germany as Mr. Bird would have us believe.

What a contrast with this beautiful series of State schools is our higgledy-piggledy educational chaos! The English 'system' is, as Mr. Bird says, 'of the most fragmentary and casual description, and the disgracefully low condition of education in this country will be gathered in part from the following painfully significant figures. In 1868 the number of students available for higher education was in England about 1·6 per cent. In Stuttgart the number is 5·2 per cent.'

In almost every point the German method of tuition is better than ours—as much better as their plan of master-training. Repetition is much in vogue. Not of a lesson, of course. That torture of the student and ignominy of the teacher is passing rapidly away wherever teaching is at its best. Repetition of the work already done is utilized at all stages of the work. Note also the excellence of the plan for teaching Geography. Instead of

beginning with the World, of which a child has rather less knowledge and certainly a less definite conception than he has of the sun or the moon, the Germans commence with the geography of the town in which the school is, and so work outwards to province, country, continent. Professor Huxley began his Physiography on a kindred plan, but appears to have grown weary by reason of the way as the book went on.

One comment on the part of Mr. Bird would be amusing were it not somewhat surprising as coming from the head-master of a mathematical school. He tells us that 'the Germans have got over their veneration for antiquity so far as to discard Euclid as a geometrical text-book.' Surely, Mr. Bird knows that in all our best schools Euclid is no longer used, and that the modern geometries, such as that of Hamblin Smith, have this long while taken its place.

The German lesson-books give the compiler an opportunity (he avails himself of it) to protest in passing against that school of reviewers who, ignorant of teaching, sneer at certain books as cram books. To the critic who, in his ignorance, does not know that the books of students are not to be committed to memory, but are, under the guidance of a skilled instructor, to serve as books of suggestion and of reference, these books are an enigma. Unfortunately for our non-educational critic, all the German school-books are of the type he condemns, and it would astonish him were he to see the use to which they are put by a good teacher in drawing out, literally educating, the mind of an apt pupil.

Space fails, or we should like to tell the reader of the absence of the chronic attack of external examinations, of the hours, of the punishments (there is little corporal), of the certificates (not prizes), of the low fees, of the State regulation of studies in all German schools. For these and many another interesting point he must turn, and he will turn if our advice is followed, to Mr. Bird's excellent little work. There he will learn that in educational matters 'they manage these things better in' Germany.

The Oxford and Cambridge French Reader.

By Frédéric Hunt. London: Hachette et Cie., 18, King William Street, Charing Cross.

Here is a book that is certainly good to the eye. None of the beginners for whom the volume is intended will be frightened or even wearied by bad paper, coarse printing, or that worst form of book-ugliness, overcrowded pages. Nor does this Reader merely

> 'Keep the word of promise to our eye
> And break it to our hope.'

The book is well done; so well, that it is worth while pointing out one or two things that seem to us blunders, and that are certainly remediable. The Preface, brief as it is, wants re-writing. The queer mixture of French and English in the name of the compiler of the book finds its reflex in the first line of the Preface. 'A precious time is often wasted.' And the phrase, 'it stands to reason,' a few lines lower down, is too colloquial for the dignity of a Preface.

More serious is the criticism on the method adopted in some parts of the book. A division is made into parts corresponding with two years of instruction, and three terms for each year. A chapter on Pronunciation opens the work of each year. We have always held that the attempt to teach pronunciation by any method other than the living voice must fail. Our contention is not modified by Mr., or is it M. (?), Hunt's book, though by use of columns, brackets, and other devices the author tries to 'temper the wind to the shorn lambs' of learners. But our adverse criticism is something more than general. The first two lines of the actual book run thus: 'The tonic accent is placed on the *last* syllable: on the *last but one* when the word ends in *e mute*. Ex. *Constitution, magnifique.*' Placing on one side the fact that the first phrase is enough to make any well-regulated child want to run out and play at once, we have in the word *constitution* an example not well chosen. To frighten a child on the very threshold of learning a language with 'tonic accents' is unwise. And the word *constitution*, as an illustration of an accent on the last syllable, presents this difficulty. 'Tion' in French, as in English, is very doubtfully monosyllabic. Some such unmistakable word as *beauté* should have been chosen. Again, it is open to question if a child, even at the end of a year's study, ought to be threatened with 'penultimate' (p. 81).

Want of judgment is, as we think, shown in making all the twelve lessons of the first term of the first year consecutive portions of one and the same story. On the other hand, the lessons of the later terms are, with two slight exceptions (5th and 6th, and 11th and 12th of term 2), each complete in themselves. It is surely the younger rather than the more advanced who ought to have their exercises and tales each complete in itself, as children are fed with spoon-meat. And this long fairy story in twelve numbers is a little unfortunate in bringing in at the close of its very first part the idea of a mother who tells lies about her own age and that of her child in order that she herself may appear younger than she is. The idea is an over-true one. But it is over-early to introduce beginners in French to our society manners, and to teach the hollowness of these with a mother for illustration.

In the extracts given for reading during the second year Mr. Hunt has shown excellent judgment and catholic taste. The names of Diderot, La Fontaine, Rousseau, De Staël, Voltaire, Buffon, Fénélon, Dumas, Chateaubriand, Hugo, Michelet, Molière, De Musset, speak for themselves, and also for the compiler's width of reading and cultured taste. Poetry is, as more than one name in the above list tells us, introduced, and introduced with careful graduation of its intrinsic difficulty. Seeing that pronunciation is treated in the book, the omission of the rules for reading French poetry seems a grave one.

Essay Cards.

By E. Noble. Manchester: J. R. Ledsham, Corporation Street.

No subject of examination in an elementary school tests better the intelligence of the teaching than does the effort at composition which is required from Standards VI. and VII. Unless ability to express himself in fairly good English, and with some degree of order and method, has been gained by a pupil, we may safely conclude that the teaching has been mechanical rather than educative. It is, therefore, absolutely necessary that good models only should be placed before a pupil. A bad style does not need acquiring; it comes naturally, and if bad models are placed before scholars, they are only confirmed in habits which have through other agencies been already acquired. These Essay Cards—thirty-six in number—have been written as models for the upper standards in schools. Although the subjects have been well-chosen, and have considerable variety, we cannot recommend them for the purpose for which they have been designed. They are very unequal in merit, and the majority are marred either by inaccuracy or peculiarity of expression, or both. About Spring the author says, 'Spring is rightly named, for it is the time when *young things spring up.*' However true this may be in some respects, the expression is, to say the least, inelegant. On card 3 we read, 'The fall of the leaf is sad in one sense,' and immediately after, 'But there is nothing really sad.' Want of order is peculiarly noticeable on card 4. Here we read, 'Winter has its peculiar pleasures, as well as summer. It is a trying time to the poor who have not fire, food, and clothing to defy the stinging blasts!' Surely, the beholding the misery and wretchedness of the poor is not a peculiar pleasure, although the relief of the distress may be. About 'stage-coach travelling,' we are told that 'the poor outsiders were glad to muffle themselves up in their great coats, *if they had any.*' They would have been clever, indeed, to have wrapped themselves up if they had not the means for doing so. A new reason has been found for wishing for holidays, for we are told that 'They are

peculiarly welcome at Christmas, because they come in the midst of the dreary winter, when the days are short, often dull and piercingly cold.' The Irishmen who come over to help us to get in our hay-harvest 'look strong and brown, though the frequent wettings sometimes bring on *rheumatic* in later years.' And so we might go on through the packet; but we have not space to make further quotations, and can only say in conclusion that we should read these essays to the class, not as models, but as showing the mistakes to avoid in writing an essay.

Cassell's Modern School Test Cards. By George Ricks, B.Sc. London: Cassell and Co., Limited, Ludgate Hill.

Each packet of these cards is divided into two series, of twenty each, the latter series containing examples slightly more difficult than those of the former. The examples are very varied, and of different degrees of difficulty, and yet they are fairly within the capacity of an average school. Examples are frequently given in the work of the previous standards; a knowledge of previous rules is thus maintained. Such expressions as Change fourpences into threepences,' and 'Change guineas into sovereigns,' should be avoided. A child, in any standard who has worked through a set of these cards, will find little difficulty in passing the Government examination.

The True Test Arithmetical Cards. By W. Watson. Blackburn: H. Isherwood, 9, Northgate.

These cards are free from those objectionable problems designed, not to test the intelligence of the scholars, but to prove a source of irritation to the teacher, and pain and dismay to the scholar. They are quite difficult enough to form a true test of the ability to work practical examples in arithmetic.

The London Arithmetic Test Cards. London: William Isbister, Limited, 56, Ludgate Hill.

The London Test Cards can be recommended to teachers seeking a set suitable for the majority of children. The sums are practical, and not too difficult, while they give ample variety. Considerable ingenuity has been displayed in making the examples, and the method of checking the answers is equally ingenious and simple.

Paragon Arithmetical Examination Cards. By J. S. Horn. Manchester: John Heywood, Deansgate.

The series with the above title is said to be specially designed for the Mundella Code. Each packet contains twenty-five cards, with eight sums on each card divided into two sets of four. There is a great similarity in the wording of many of the examples, and, as the whole of the questions in Standard I. are in figures, for examination purposes they will be useless in those districts where the sums are invariably dictated. The type is very small, and in many places the printing is indistinct. With these exceptions the series is a suitable one, and may be used with advantage as an alternative series. The answers are not published with the cards, but in a separate book.

Prairie Pictures: Lillith and other Poems. By Jno. Cameron Grant. London: Longmans, Green, and Co.

'Songs from the Sunny South' and 'A Year of Life' have come from the same pen, and Mr. Grant seems to have published these poems in answer to an appeal from a critic of his former works. We cannot say that his reputation will be much enhanced by the present publication; for while the short poems, which give the principal name to the book, show great accuracy of observation, they also contain many crude lines, put together almost regardless of rhythm, and are in several instances on subjects which do not readily lend themselves to poetical treatment. Perhaps the peculiar stanza adopted has something also to do with the want of smoothness which marks the verses; for when the author adopts the sonnet, as in 'After Dark' (in our opinion the best of the pictures), or blank verse, as in 'Over Sea,' he is much more at home, and his thoughts seem to obtain readier utterance. Mr. Grant is anxious to impress upon his readers the boundless wealth of food and space which the grand possession of Canada gives to the people of this country. His poems tell of a nature full of deep religious feeling, and of active sympathies for the poor outcasts of our overcrowded cities. Intense hatred is manifested towards those who seek for place and power only that they may serve themselves.

Of the ultimate triumph of truth and right over falsehood and wrong, the author discourses with great freedom and certainty in the poem 'Vicisti,' and he shows his ability to write true pathos in the poem of true heroism which he has called 'In Memoriam.' Notwithstanding the apparent haste displayed in writing some of the earlier poems of the book, and their want of revision, Mr. Grant will bear reading more than once. His poems grow upon one, and new beauties show themselves on every subsequent perusal. This, we believe, is one of the surest tests of a true poet. We have not space for quotation, but must refer our readers to the book itself, in proof of the correctness of our views. Several typographical and orthographical errors have crept into the otherwise well-got-up book. We get *tho* and *thro* for *though* and *through*, all through the book; on p. 41 we have *e're* for *e'er*, and *fairy* in two forms, *faerie* and *faery*, on separate pages. On p. 2 we have *quiet* for *quite*; on p. 13, *bires* for *byres*; and on p. 19, *stemed* for *stemmed*; on p. 27, *convolvolus* for *convolvulus*; on p. 32, *thro* for *throw*; on p. 37, *urks* for *irks*; on p. 44, *t'was* for *'twas*; on p. 45, *t'would* for *'twould*; on p. 52, *lovlier* for *lovelier*; on p. 55 the old form *agen* for *again*; on p. 67, *lovliest* for *loveliest*. Some of these may be modern methods from across the Atlantic, but till there is some common desire expressed to adopt a different kind of spelling, we think it well, in English-printed and English-published books, to adopt the generally accepted forms.

The Children's Pastime. Pictures and Stories. By Lileth G. Séguin. London: Hodder and Stoughton.

In books meant for children every picture should tell its story, and every story should present a picture, and both pictures and stories should be very beautiful. But in this volume there is no beauty of any kind. All, with the exception of the binding, is hopelessly ugly. It is difficult to say which is worse, the stories—with their slipshod English, and equally slipshod sentiment, their dulness and morbidity—or the pictures, which are simply indescribable. On the title page we are told that Millais, W. Small, F. A. Frazer, E. G. Dalziel, and others are responsible for the 'illustrations;' but it seems incredible that such artists can have had any hand in a production so thoroughly inartistic. Their co-operation can only be explained on the hypothesis that they have allowed old pictures of theirs—and the clothes of the men, women, and children presented all fix the date of the drawings at least twenty years ago—to be used, and that many and cruel liberties have been taken with their work. That the painter of Cinderella and Little Red Riding Hood could have drawn the sickly children in 'Gerty's Unlucky Day,' or the little monster Morna (p. 165), is impossible. That W. Small could be responsible for the abomination on p. 145, we refuse to believe. Death, Madame (or Madlle.) Séguin apparently thinks a cheerful and appropriate subject for little children. There is a 'Farewell' to be sung 'slowly, and with expression;' a 'Young Widow,' a 'little grave,

sundry orphans. And she also wants the little ones to know all about 'Baby Shows!' Madame Séguin calls her book the 'Children's Pastime.' We think it more likely to be their nightmare.

Andrew Marvel and His Friends. By Marie Hall. London: Hodder and Stoughton.

It is very pleasant to turn from Madame Séguin's book to Mrs. Hall's, which we are not surprised, but very glad, to see has reached a fourth edition. Despite her ardent sympathy for the sturdy 'Ironsides' and her contempt for the Stuarts, Mrs. Hall is never unjust. She does not assume that a man must be necessarily good or bad because he is a 'Roundhead' or a 'Cavalier;' she is a very faithful historian, and an artist. Both her fidelity and her true artistic instinct are shown in her rejection of the old and untrue version of Marvel's death by poison, for the less romantic, but really more pathetic and effective one, the details of which we owe to Dr. Gee.

Mrs. Hall has given also another proof of her ability. While she makes us take a vivid interest in Marvel; while she succeeds in making us know him 'in his habit as he lived'; he rarely appears in the story itself. We know him through his friends and his effect upon them. To have introduced the great satirist would have been, to say the least, rash.

We have but two faults to find with this excellent work, and they are so trivial it seems almost ungrateful to speak of them at all. In the first place, the heroine, Alice—sweet, and strong, and lovable, though she be—is perhaps a little too much given to a nineteenth century habit of introspection. In the second place, Mrs. Hall does not make sufficiently clear the reason why the Royalists were so anxious to seize Hull. She forgets, no doubt, that her readers are not all such well-read historians as herself, and that many must have forgotten that Hull was, in Green's words, 'the great magazine of the North.'

The volume is very beautifully illustrated by lovely sketches of old Hull, and there is a splendid photograph of Andrew Marvel's statue.

Heroic Adventure. Chapters in Recent Exploration and Discovery. London: T. Fisher Unwin.

This is a most able compilation from the works of some of the greatest explorers of our day. It will be welcomed by those grown-up people whom a long course of magazine reading has rendered incapable of getting through a volume, and who want to have the salient points of a book put into a few pages for them. It will be welcomed by all the young folk who love tales of stirring adventure. The boys and girls must be *blasés* indeed who are not moved by the efforts of such men as Schweinfurth, Prejevalsky, Markham, Vambéry, Serpa Pinto, and Nordenskiöld.

The compilers of this volume have wisely allowed the heroes, so far as possible, to tell their own stories; and not the least charm of this fascinating volume lies in the perfect simplicity, the unconscious grandeur of the narrators. We know many books with 'a moral purpose' that teach no such moral as this book, in which the 'purpose' is never allowed to obtrude itself. Boys and girls will be the better and the braver for reading of these brave men, who, for the sake of science alone, perform deeds of heroism by the side of which the acts of the boldest soldiers seem insignificant.

The accounts of some of the adventures are so wonderful that we feel they must be true. By the side of them Othello's experiences seem commonplace, and his 'men whose heads do grow beneath their shoulders' are not half so interesting as Schweinfurth's little 'pigmies,' whose 'average height is four feet ten inches.'

To grumble is the privilege of the Englishman and the reviewer, and even this book 'shall not escape.' Surely, in a book meant for boys and girls it would be well if such words as 'ethnological' and 'orthognathous' (which, by the way, is mis-written 'orthognatic') were explained; and if small maps, illustrating the regions described, were added, they would add incalculably to the use and profit of the book. The binding, but for that gold band across, and the illustrations are very good.

Magna Charta Stories. Struggles for Freedom in Former Times. Edited by Arthur Gilman, M.A. London: Blackie and Son.

There is a 'plentiful lack' of chronological order in this otherwise very excellent little book. To be suddenly transferred from the times of John and his barons to that of Horatius, or Miltiades, or Leonidas, or Hermann, or Alfred the Great, or Charles Martel, is somewhat perplexing.

Three of the twelve 'stories' are told by the editor, the rest by different ladies, all of whom we suspect are Americans. The name of one of them, at least, we all know—that of Nathaniel Hawthorne's daughter. As to the editor himself, his speech bewrays him. On p. 56, and again on p. 59, when wishing to give us an idea of the smallness of Attica, he compares it to Massachusetts and Rhode Island. We cannot think an Englishman would have selected either as terms of comparison.

All these stories of the great men who fought for freedom, and who 'loved honour more' than aught else, are well told, conveying most pleasantly some knowledge of many great historical events. On p. 117 we note a curious error. We are told that Napoleon 'made famous' the motto '*Toutefois l'audace.*' To begin with, '*toutefois*' would mean nothing; and secondly the words '*Toujours de l'audace*' or '*Encore de l'audace*' were spoken not by Napoleon, but by Danton. The printing, binding, and illustrations of this book are admirable.

Bunyip Land. By G. Manville Fenn. London: Blackie and Son.

'Bunyip' is the name a black boy, an Australian, gives to evil spirits, and Bunyip Land is New Guinea. Hither come Joe Carstairs, his faithful black follower, his friend a young doctor, and an eccentric youth, Jack Penny, not forgetting Jack's dog Gyp. They have come to search in the interior for Joe's father, a botanist, who has disappeared, and who has not been heard of for three years. Of course, Professor Carstairs is found at last, but after such numbers of thrilling adventures that, but for our certainty that the hero will 'come through' all right, we should be quite unhappy. We are sure boys will delight in this splendidly 'got up' volume, and we are much mistaken if Jack and his dog Gyp are not the great favourites, and preferred to Joe, who is something of a prig.

Menhardoc. By George Manville Fenn. London: Blackie and Son.

This is a really charming story of 'Cornish nets and mines.' We do not know if the 'local colouring' is all true, but we do know that this story will delight all the boys and girls who are lucky enough to have it given them. We are sure also that next summer many a paterfamilias will be coaxed by his young hopefuls into taking a trip to the West.

There is, however, as it seems to us, one serious fault in this book. 'To get on' is the chief doctrine enforced. Perhaps it were wiser to teach our boys there is something greater and better even than 'getting on.' Again, we think Mr. Fenn weakens his teaching when he tells boys all an *English* man is expected to be, rather than what an honest, brave man is. We must confess, too that we are unable to reconcile ourselves to the theory of 'Mr. Temple,' that, because he has capital, he is justified in taking three-fourths of the 'works'—which he has

only been able to make anything of through the skill and knowledge of the sailor lad, Will Marion—thus leaving the discoverer of the 'lode' only one-fourth of the profit.

All these objections, however, will not prevent this story from being as popular as it deserves to be.

Science Simplified for Little Ones. By M. H. Senior. Manchester: R. J. Derfel.

This little book, we are told in the preface, is intended to familiarise children with the chief facts of science before they enter the regular classes. At what age they are supposed to enter the regular classes we are not told; but as the author says that it can be used either as a reading-book or a compendium of home lessons, when one article can be learnt at a time, we may assume that the book is intended to be read and learnt. What sort of statements, then, are children to learn under the name of science? The book contains ninety-eight lessons, one to a page. There are no illustrations, no connection between the subjects, no gradation in the difficulty of the lessons. The first lesson is on the fish, the second on the bird's eye, the third on the sleep of plants, the fourth on railways, and the fifth on the atmosphere. The seventeenth lesson to the little children, 'whose limited understandings' have not yet qualified them to enter the regular classes, is on centrifugal and centripetal force. Of course, the subject is utterly unsuited to such children. And how is it presented? Reference is made to a can swinging round by a string, and to the fact that if the string broke the can would dart off. 'This wish,' the author says, 'to get away is called centrifugal force.' 'Now, while the can is anxious to fly off, you are really pulling it to the centre; and if it suddenly gave up its desire to leave you, it would drop on your shoulder or fall to the ground. This drawing towards you is called centripetal force, and when the two are acting together on a body, that body will always proceed in a curved direction.' This is a preparation for a future study of dynamics. On page 37 the child is to be taught that 'thermometer' means a measurer of heat. And so on throughout the book. How sad it is that the heads of little children should be filled with inaccurate and useless statements, which waste their time and prove a positive hindrance to any future progress!

With children the all-important thing is to lead them to observe carefully, and to express accurately, what they see and hear and feel. The innate curiosity needs encouragement and direction. The retentiveness of their memories should be taken advantage of to store up really useful knowledge, such as the words of their own language, or of French and German, and not to learn by heart statements which they do not understand, and which, indeed, as in this case before us, are misleading or untrue. Surely it is not too much to hope that with the newer lights on the theory and practice of education, books like this so-called 'Science Simplified' will be entirely unknown. It is written on an entirely wrong principle, full of useless statements, often false, and certain, if it falls into the hands of scientific men, to bring discredit on the teachers who used it.

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many physical features of the country as Aber and Inver = mouth of a river, as Aberdeen, Inverness; avon = water; ben = mountain; glen = a valley; mull, ross = a cape, etc. Also from those Celts who were reduced to slavery we have a few such words as kiln, basket, cradle, etc.

The Roman Influence.—The Romans occupied the country for about 400 years, having first come over in 55 B.C., and left about 410 A.D. The occupation, however, was military, and thus there was little intermingling between Romans and Britons. In our language we have but few traces of this occupation, the chief being from such words as castra, a camp, Chester; colonia, a colony, Lincoln; strata, a road, Stratford, street; pons, a bridge, Pontefract, etc. When St. Augustine came over nearly 200 years afterwards, the religion of the country gradually changed, and many fresh words, chiefly relating to ecclesiastical matters, were introduced, as monk, minister, apostle, cloister, epistle, etc.

Teutonic Element.—The foundation of our present language rests upon that of the Saxons who came over first in 449 A.D. Nearly the whole of our grammar is derived from them, and almost all of the most common nouns, verbs, and adjectives. In ordinary conversation and in the works of our best modern writers, words of Saxon origin far outnumber those derived from any other source. When the *Normans* came over in 1066 many fresh terms were introduced chiefly relating to war, hunting, feudalism, and law, as lance, venison, baron, plea, etc. Intercourse with the nations on the Continent brought about the introduction of many foreign words, and our language now consists principally of Saxon, French, Latin, Greek, and Celtic words.

French.

1. Translate into English :—

C'était le moment où le Portugal se livrait, dans un esprit de colonisation ou d'aventures, à des tentatives navales incessantes pour relier l'Europe à l'Asie, et où Vasco de Gama, le colon portugais, n'était pas loin de découvrir la route maritime des Indes par le Cap de Bonne-Esperance. Colomb, convaincu qu'il trouverait une route plus directe en s'elançant droit devant lui vers l'ouest, obtint, après de longues sollicitations, une audience du roi, pour lui révèler ses plans de découverte et pour lui demander les moyens de les accomplir.

This was the moment in which Portugal devoted herself in a spirit of colonisation or adventure to constant naval attempts to connect Europe with Asia, and in which Vasco de Gama, the Portuguese colonist, was not far from discovering the maritime route to the Indies by the Cape of Good Hope. Columbus, convinced that he could find a more direct route, in setting out straight before him towards the west, obtained, after many solicitations, an audience with the king, to reveal to him his plans of discovery, and to beg the means by which to accomplish them.

2. Parse fully the words où, ou, se, était, que, vers, du, incessantes, après, convaincu, trouverait, longues, obtint, découverte.

Où = in which (lit. where, an adverb), rel. pro., neut., sing., 3rd, agreeing with its antecedent 'moment.'

ou—a conjunction, joining 'de colonisation' and 'd'aventures.'

se = herself, per. pro., fem., sing., 3rd, obj. case by 'livrait.'

était—intrans. verb, ind., imperfect tense, sing., 3rd, agreeing with 'Vasco de Gama.'

que—a conjunction.

vers—a preposition governing 'l'ouest.'

du—a preposition governing 'roi.'

incessantes—an adjective qualifying 'tentatives.'

après—a preposition governing 'sollicitations.'

convaincu—past participle of 'convaincre.'

trouverait—trans. verb, cond., pres., sing., 3rd, agreeing with 'il.'

longues—adjective qualifying 'sollicitations.'

obtint—past participle of 'obtenir.'

decouverte—com. noun, fem., sing., 3rd, obj. by 'de.'

3. Write out in full the principal tenses of the verbs in the last question.

Etre, to be.

PRESENT.	IMPERFECT.	PRETERITE.	FUTURE.
Je suis	J'étais	Je fus	Je serai
Tu es	Tu étais	Tu fus	Tu seras
Il est	Il etait	Il fut	Il sera
Nous sommes	Nous étions	Nous fumes	Nous serons
Vous êtes	Vous etiez	Vous futes	Vous serez
Ils sont	Ils etaient	Ils furent	Ils seront

Convaincre, to convince.

PRESENT.	IMPERFECT.	PRETERITE.	FUTURE.
Je Convaincs	Je convainquais	Je convainquis	Je convaincrai
Tu convaincs	Tu convainquais	Tu convainquis	Tu convaincras
Il convainc	Il convainquait	Il convainquit	Il convaincra
Nous convainquons	Nous convainquions	Nous convainquimes	Nous convaincrons
Vous convainquez	Vous convainquiez	Vous convainquites	Vous convaincrez
Ils convainquent	Ils convainquaient	Ils convainquirent	Ils convaincront

Trouver, to find.

PRESENT.	IMPERFECT.	PRETERITE.	FUTURE.
Je trouve	Je trouvais	Je trouvai	Je trouverai
Tu trouves	Tu trouvais	Tu trouvas	Tu trouveras
Il trouve	Il trouvait	Il trouva	Il trouvera
Nous trouvons	Nous trouvions	Nous trouvames	Nous trouverons
Vous trouvez	Vous trouviez	Vous trouvates	Vous trouverez
Ils trouvent	Ils trouvaient	Ils trouverent	Ils trouveront

4. Examine the construction in the following expressions :—'à des tentatives,' 'la route maritime des Indes,' 'en s'élançant droit devant lui,' 'pour lui demander les moyens de les accomplir,' 'après de longues sollicitations.'

'*a des tentatives*' means to some attempts; the word 'des' in this sentence means some.

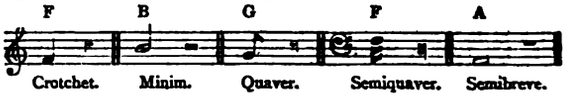
'*la route maritime des Indes*' means the maritime route to the Indies. In this sentence the word 'des' means 'of the' (lit.); thus 'des' stands for 'some,' or for 'of the' before a plural noun. Observe that in both these sentences the noun is placed before its adjective, this being the common rule in French, although there are several exceptions.

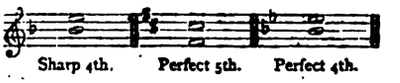
'*en s'élançant droit devant lui*' means in setting (himself) out straight before him; 's'élançant' is an example of a class of verbs peculiar to the French language, termed reflective, which are never used without the personal pronoun himself, herself, etc.—thus, 's'élançant' means himself setting out.

'*pour lui demander les moyens de les accomplir*' means 'for to ask of him the means to accomplish them.' The objective 'lui' is generally placed before the verb; 'de' seems superfluous, but the French use that preposition more often than the English.

'*après de longues sollicitations*' means after many solicitations. 'De' here means 'some,' and takes the place of 'des,' which is not placed before an adjective in the plural number.

Music.

1. Write the pitch-names (C, B, &c.) and the duration-names (crotchet, minim, &c.) of the following notes, and write the signs for rests of corresponding value :—

2. Describe the intervals (Major third, &c.) formed by the following pairs of notes :—



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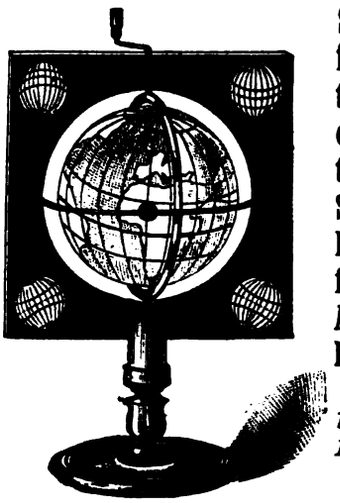

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The boys who learnt to swim were rewarded with a certificate, which they highly valued. The children were never allowed to stand about after undressing nor after bathing, when they rubbed themselves well all over with a rough towel. These the children provided themselves, and it was a punishable offence to leave the bath with wet hair.

We will not stop to describe the swimming races at the end of the season. We should like to attempt that between the two schools, for instance, when, as with the cricket, there was the same eager struggling for the first place.

Prizes were given, in the same year as the events recorded in the last chapter, at a public meeting. After the distribution, at which friends from both schools were well represented, the chairman, who was the chairman of Mr. Henton's committee, presented him with a very beautiful timepiece, on behalf of the scholars, teachers, and committee. After which the Chairman of the School Board said that he had a like pleasant duty to perform on behalf of the Board, teachers, and scholars, in presenting a writing-desk to Miss Danford.

Within a month these two personages had bidden adieu to Mr. and Mrs. Stafford and all their friends, and had gone to open a boarding-school in a town in one of the metropolitan counties.

CHAPTER IX.—THE LAST.

MRS. HENTON, *née* Alice Danford, was now to help her husband in the new undertaking. We will not describe the building in which Mrs. Henton, who had lately had a considerable sum of money left him by his uncle, had taken every pains to ensure those things so necessary to the health of his scholars.

We must, however, say a few words about the care of his dormitories, which part of the building is frequently not properly cared for.

The younger boys were to be accommodated with large open sleeping apartments, with beds in each apartment for twelve children. The elders were to have their rooms divided into cubicles; the partitions being made of wood, and so arranged that they were nowhere, except at their supports, touching the floor. They were sliding partitions, and could be removed altogether, if necessary.

The utmost care was taken that the rooms should be ventilated day and night, and in the winter they were slightly warmed.

In the middle of the rooms, the whole of the washing-basins were arranged, one to each boy.

No visiting in cubicles was permitted on any account. In fact, so stringent were the rules, that one boy who had disobeyed three times, after repeated caution, had been immediately expelled.

Mrs. Henton performed her part in seeing that the servants kept the bedrooms perfectly clean. She was also most careful in superintending the purchase, and also the cooking, of all the food, knowing that in such a school, all the care taken to ventilate, warm, and in other ways care for the health of the body, would be altogether unsuccessful without the body being well built up by proper nourishment.

Mr. Henton was most successful in his new school, assisted by his amiable and affectionate wife. Constant correspondence was kept up with the Staffords, and it was generally arranged that the two families, numbering a few more heads than formerly, should spend their vacations together.

Both masters earned the love and respect of their pupils and their parents, and hope to be able to retire in their old age to the pretty little town of Dawlish, in which they have spent many a happy hour together—in which wish we most heartily join.

THE END.

Article 106 (*b*).

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Section II.—Phenomena of Nature.

LESSON—THE AUTUMN.

WE have already spoken about two parts of the year. Can you tell me what they are? The Spring and the Summer. How many parts have we still to talk about? Two. What are they? The Autumn and the Winter. We have one name for all these parts; do you know what it is? Yes, we call them the Seasons. How many Seasons are there? Four. What are their names? Spring, Summer, Autumn, and Winter.

Now, you can tell me some of the work that is done in the Spring—what kind of weather we have—the flowers that grow, etc. Then you can also tell me about the Summer—the nice warm weather and long days—the bright sunshine—the lovely flowers, and the fruit, etc. Then the next season is called Autumn, and I want you to try to tell me what goes on then, the flowers that grow, and the kind of weather we have.

Do you remember the hot weather we have in the Summer, and the very long days, and how you liked playing in the garden, and did not go to bed till it was very late? Well, when the Autumn comes the days begin to get much shorter, and I daresay you will notice that it is too dark to play out-of-doors in the evening, and so you go to bed earlier. Do you mind that? No, because we cannot see to play, and we can go to sleep when it is dark. What do you notice about your clothes? Our mothers are careful to wrap us up well when we go out. Why? Because the weather is much colder, and we might catch cold if we were not well wrapped up.

How did you say the gardens looked in the summer? Very bright and pretty. Why? Because they were full of lovely flowers. What else did you notice in the gardens? The birds singing, the bees flying about from flower to flower, and butterflies, and many other things. Then the air is filled with the scent of the pretty flowers. Yes, that is quite right. In the Autumn, however, you will not find the butterfly and bee. Do you know why? Because the weather is cold. Then most of the bright flowers have died, especially after the first part of the Autumn has gone. We still have a few flowers left. Can you tell me the names of any? Asters, dahlias, and chrysanthemums. Yes, the chrysanthemums are the real Autumn flowers, and remain a long time in the garden. And now, I want you to tell me about the fruit. You remember that in early summer we had strawberries, gooseberries, raspberries, etc., and later we had cherries, and some apples and pears. Can you tell me what we have in the Autumn? Apples, pears, and oranges. Where have you seen the oranges growing? That is right; we cannot see them in our gardens for they grow in a warmer country. They are sent to us from countries that are very much hotter than ours, and they come a long way. Do you know how they are brought to this country? They are packed in large boxes, and brought across the sea in ships.

Now, I want some of you to tell me the work that is done at this time of the year. The harvest is finished. Do you know the names of some of the things that are gathered at this time? Yes, apples and pears. And what else? Corn and hops. You will see the men very busy ploughing the ground, and sowing seeds for next year's crops.

Then if we stay with the farmer we shall find him very busy threshing the corn. Can you tell me what that means? Why do they thresh corn?

The summary should consist of the names of the dif-

ferent flowers and fruits that grow in the Autumn, and of the different work done by the farmer and gardener at this time of the year.

Section III.—Scenes of Common Life.

LESSON—MEANS OF WARMING AND LIGHTING.

(A) *Means of Warming.*—Now, children, will you tell me what kind of weather we have in the summer? And in the winter? How do you often feel in the winter? Do you like feeling cold? What do you do to warm yourselves? Run about and play at games that make us move quickly. Do you run about the house to keep warm? What do we have in our houses to keep us warm? Fires. Do we have fires in the summer-time? Yes, in the kitchen. Why? To cook our food. But do we have a fire in the sitting-room? Why not? Because it is quite warm enough without a fire. How is that? The sun is so hot and shines so brightly, that it makes all the rooms warm. Then we have found out that the sun keeps us warm in the summer, but in the winter we are obliged to have fires to make us warm.

When you are in the schoolroom in the winter, do you feel cold? How is that? Are there any fires in your school? Well, I wonder how the room is warmed. Well, Mary, what do you say? There are a great many hot pipes in the room. Whereabouts are these pipes? All round the room, under the floor, and down the walls. How do you know they are hot? I have put my hands on them. Yes. I often see little boys and girls putting their hands on the pipes, and sometimes I see the boys putting their feet on them. Why do they do this? To make their hands and feet warm. Do you know what makes the pipes hot? Well, listen, and I will tell you. There is a very large fire making the water very hot, and this hot water runs through the pipes and makes them hot. By the time the water has been through the pipes it is cold and fresh hot water goes into them, and in this way the pipes are kept warm. The caretaker only has one large fire to see to, and he has not the trouble of clearing away a great deal of ashes from the fire-grates like your mother has to do at home. Harry says that he knows a school where they have very large fire-grates. Well, this is not as nice as the pipes. Can you tell me why? In our large room it does not matter where you sit, you will find it warm, but in the large rooms warmed by the fire-grates, the children who sit near are very warm, and the children who sit at the other end of the room will be very cold, although there is a large fire in it.

If any of the children should have seen the steam warming apparatus, the teacher might explain that steam is passed into the pipes from a large boiler instead of water. A simple experiment might be made before the children by means of a spirit lamp, kettle, and piece of metal tubing.

Now, you can tell me two ways of warming our rooms. What are they? Fire-grates or open fires, and hot-water pipes.

How many of you have been to church? Do you feel cold there? What makes the church warm? Yes, there is a fire there, but is it an open fire like ours at home? No, it is a large stove. These stoves are very useful for warming large rooms. They throw out a great deal of heat. Very often in churches you see the gas burning, even in the morning. Do you know why the gas is alight? To give us light. Do we want the gaslight when the daylight is good? The gas is lighted to help to warm the church. Well, John, what do you want to say? The school I used to go to had large stoves in the rooms. Oh, yes. Stoves are also used to warm many other places besides churches and schoolrooms.

Sometimes people have gas stoves to warm their rooms; that is, they burn gas always instead of fires. Some of these stoves look very pretty, and when alight, look like the open fire. They are very clean. What does your mother have to do after there has been a fire? She has to clear away the ashes, and clean the grate. With a gas stove she would only have to turn out the gas; there would be no dust or dirt. Then, when she wants a fire she would not have to carry coals about, or paper and wood. She would only have to light the gas. You see, then, that this is another way to warm the rooms.

Sometimes rooms are warmed in the following way by means of hot air. A large furnace, with a shaft leading up to the room is built in the cellar, or at the bottom of the building. What do you mean by a furnace? What is a shaft? The teacher should sketch this on the blackboard, and then point out that a grating is put into the shaft leading into the room, and that this grating can be opened or closed whenever the teacher wishes, and explain why. A very large fire is made in the furnace, and the air passing over it is made very hot, and then goes up the shaft. Where does the shaft lead to? What comes through the grating? How does this warm the room? You will notice on the other side of the room another grating, and if you put your hand there you will not find hot air. This grating lets the air out after it has passed through the room. You see, then, that this is something like the hot-water pipes. The hot water runs through the pipes, and when cold, passes out. The hot air passes through the room, and leaves it at the other end. If you put your hand, or even stand near the grating in the shaft, you will feel the hot air rushing into the room. This way of warming the room keeps every part of the room warm.

Now, I want you to think about what we have been talking; and tell me the different ways of warming the rooms, etc.

We warm rooms by means of open fires or grates.
We warm rooms by means of closed fires or stoves.
We warm rooms by passing hot water through pipes.
We warm rooms by passing steam through pipes.
We warm rooms by means of gas in gas stoves.
We warm rooms by means of hot air.

(B) *Means of Lighting.*—Now I want you to think about something else. When it gets dark what must we do if we want to see? We must get a light. What kind of light do we get? Well, one little girl says her mother lights the gas, and another says her mother lights the lamp, and here is a little boy who says his mother lights a candle. So you see there are several ways of getting light. Tell me them again. The gas, the lamp, and the candle. We will have a talk about each of them.

How does your mother light the gas? Yes, she turns on a little tap, and then lights it. With what does she light the gas? With matches or a piece of lighted paper. Does your mother have to put anything in the tap? Can you see the gas before it is lighted? How, then, do you know when it is turned on? That is right, you can smell it. Can you smell it when it is alight? No, there is no smell when it is alight. But there is another way you can tell when the gas is turned on. Can you tell me? Yes you can hear it. Do you know that you should never touch the gas pipes? Why? Well, I will tell you. If the gas is turned on without being lighted, the gas keeps on coming out of the pipe, and the room gets quite full of gas. Then if any one goes into the room with a light the gas would catch fire, and there would be an explosion. Have you ever heard of an explosion? What does it do? The teacher might here relate a short account of a gas explosion, showing the damage done, etc. What kind of light do we say the gas gives? A nice bright light. What must you remember about the gas? That it is very dangerous, and we must not touch the pipes. If ever you smell gas what should you do directly? Tell mother, so that she can see to it. Yes, sometimes there is a very small hole in the pipe, and the gas comes out or escapes. Your father must then stop up the hole or call the gasfitter to it.

Now I should like you to tell me something about the lamp. How many of you have lamps at home? What does your mother put into the lamp? Oil. What oil

does she use? What else is in the lamp? The wick. Of what is the wick made? Which part of the lamp does your mother light? The wick. Now you must also be very careful with the lamps, for if you knock the mover they are very dangerous; the oil quickly catches light, and it is very difficult to put out, and even if the oil did not burn it would spoil whatever things it fell upon. Which do you think your mother likes, the gas or the lamp? Why? Because the gas is easily lighted, and is no trouble. And the lamp? The lamp has to be cleaned and filled with oil every day. There is another kind of lamp in which we do not burn oil. Do you know what we put in them? Yes, spirit. Do you know the name of the spirit? Ah, Harry knows, because he says he fetches it for his mother. Look, I will write it on the board; you see it is a very long word for you: meth-y-lat-ed spir-it. For what does your mother use these lamps? For carrying about the house, etc.

We have still one light to talk about. What is it? The candle. Of what is the candle made? Of tallow, and a wick in the middle. What use is the wick? Of what use is the tallow? In what do we stand the candle? Why? Do we get as much light from the candle as we do from the gas or lamp? Why does not your mother like you to carry the candle? Because we drop the grease about the house.

Then there is another light you have not told me about, and perhaps many of you have not seen it. If you go to some of the railway stations you can see it. It is also to be seen in large shops, and also in some of the streets. I mean the electric light. Hands up those of you who have seen this light. What kind of light is it? It is very, very bright, and looks very nice. You shall learn more about this another day.

Section IV.—Common Employments.

LESSON—THE ERRAND BOY.

We are going this morning to talk about the errand-boy, and I want you to tell me all you can about him. What work do errand-boys have to do? They have to take messages, parcels, and letters for their masters. What do they do when they are not thus running about? Who has seen an errand-boy busy in the shop? Well, tell me some of the things he was doing. Yes, he has to sweep and dust the shop, clean the windows, etc., light the fires, and some of them have to clean knives and boots, etc. Then the big ones take the shutters down and open the shop. So you see they have to get up early in the morning, and they generally have to put the shutters up at night. The duties of errand-boys should be carefully recapitulated before proceeding with the lesson.

Now, children, how many of you would like to be errand-boys when you are big enough? Very well, then, we will see what kind of boys you must be, in order to make good and useful errand-boys. Let us see what is the first thing the errand-boy has to do. He has to take messages and parcels. When his master is giving him a message, what should he be doing? Listening. Yes, and very attentively. It would not do for him to be looking at, or thinking about anything else. Why? Because if he did not hear the message properly, he would probably make mistakes when he delivered it, and this might cause a great deal of trouble. So we say, 'An errand-boy must attend to what is said to him.'

Again, perhaps the errand-boy might have several messages and parcels to deliver, and his master would then write the addresses on the parcels. Then what must the boy be able to do, so as to leave the right parcel at the right house? He must be able to read. Very often he would receive money for the goods, and then what would he have to do? He would have to write 'Paid,' and also his name on the bill. You see, then, that errand-boys must be able to read and write. Then while you are at school, if you want to be errand-boys, what must you learn to do? We must learn to read and write. Yes, you must work very hard while you are at school, for you will have but little time or chance afterwards.

When the boy has started on his errands, what should he do? He should go quickly to the places he has to call at, and return as soon as possible. Who has ever seen a boy going on an errand? Very well, Mary, what did you see him doing? He was carrying a parcel, and going along very quickly. Was that the right thing to do? Yes. Well, John, what have you to say? I saw a boy who had put his basket down, and was playing at marbles with some other boys. Was that right? Why? Because he was playing when he ought to have been working. Yes, and very likely the people to whom he was going were waiting for the things he had for them. What do you think his master would say if he saw him doing such a thing? He would be very angry, and very likely he would not keep him as his errand-boy, and so the boy would lose his place. The class should then repeat, 'An errand-boy should go quickly when sent on an errand.'

If a master wants an errand-boy, do you know what he does? Yes, he puts a card in the window with the words 'Errand-boy wanted' printed on it. Boys read the card, and if they want work they go into the shop to see if the master will have them. Now which of the two following boys do you think a master would choose? One has very clean hands and face, his boots well polished, and his clothes, though perhaps not new, nicely brushed. The other has dirty hands and face, his clothes very untidy, and his boots not blacked. The first one. Why? Yes, we do not like to see a dirty, untidy boy about the house. The children should then repeat, 'An errand-boy should be clean and tidy.'

Suppose a boy had to take a very nice cake to a house, but going along, he thought he should like a cake like that to take home with him, and then, instead of leaving it at the proper place, he takes it home. What do you think the lady would do who expected the cake? She would go to the shopkeeper and tell him that she had not received the cake. What would the shopkeeper then do? He would call the errand-boy and question him about it. Perhaps the errand-boy would say that he had left it at the house. What would this be doing? Telling a story. And what had he done when he took the cake home? He had stolen it. Do you think the boy would keep his place? No, the master would soon find him out. Yes, and then he would lose his situation, and what is worse still, he would find it very difficult to get another one. Do you know way? When a master takes a new errand-boy he generally wants what is called a character, and, therefore, he asks the boy's last employer all about him. The children should then repeat, 'An errand-boy should be truthful and honest.'

The teacher, proceeding in a similar manner, should show the necessity of errand-boys being respectful, obliging, obedient, and industrious, and also how unpleasant it is to have to deal with boys who do not possess these qualities, and how pleasant it is to work with good, happy, industrious boys.

As a recapitulatory exercise, the children might write the following on their slates, or repeat from blackboard:—

An errand-boy has to take messages, parcels, and letters.

He has also to sweep and dust the shop, clean the windows, etc.

Sometimes he has to clean boots, light the fires, and open and shut the shop.

An errand-boy must be able to read and write.

He must be attentive, active, clean, truthful, and honest.

(*To be continued.*)

ANSWERS TO
Pupil Teachers' Examination Papers.
FIRST YEAR.

Pupil Teachers at end of First Year.

Three hours and a half allowed.

Arithmetic.

MALES.

1. Add together $\frac{8}{9}$ of 7, $\frac{9}{7}$ of 8, $\frac{7}{8}$ of 9, and $\frac{8}{9}$ of 10, and say what fraction of $37\frac{1}{17}$ is $27\frac{1}{17}$.

(*a*) $\frac{8}{9}$ of $7+\frac{9}{7}$ of $8+\frac{7}{8}$ of $9+\frac{8}{9}$ of 10

$= \frac{56}{9}+\frac{72}{7}+\frac{63}{8}+\frac{80}{9}$

$= 5\frac{8}{9}+6\frac{2}{7}+7\frac{7}{8}+8\frac{8}{9}$

$= 26\frac{4320+432+441+448}{504}$

$= 26\frac{1741}{504}$.

$= 29\frac{317}{504}$. Ans.

(*b*) $27\frac{1}{17}$

$37\frac{9}{17}$

$= \frac{1000}{37}$

$= \frac{1000}{1369}$.

$= \frac{37}{37}$. Ans.

2. If £1 is worth 25·3 francs, find the value of £4 7s. 6d. in French money.

£4 7s. 6d. $=$ £$4\frac{1}{8}$ $=$ £4·375

Since £1 = 25·3 francs

£4·375 $= 25{\cdot}3 \times 4{\cdot}375$

$= 110{\cdot}6875$ francs. Ans.

3. Which is the greater, and by how much, ·0475 of a guinea or ·325 of half-a-crown?

·0475 of a guinea $= {\cdot}0475$

$\times 21$

475

950

s. 9975

$\times 12$

d. $11{\cdot}9700$

·325 of half-a-crown $= {\cdot}325$

$\times 30$

d. $9{\cdot}750$

d. $11{\cdot}97 - 9{\cdot}75$d. $= 2{\cdot}22$d.

∴ ·0475 of a guinea is the greater by 2·22d. Ans.

4. A can reap $\frac{1}{5}$ of a field in $2\frac{3}{4}$ days, and B can reap $\frac{1}{6}$ of it in $4\frac{1}{2}$ days. In what time could A and B reap the whole field if working together?

A can do $\frac{1}{5}$ in $2\frac{3}{4}$ days

∴ „ $\frac{1}{5}$ in $\frac{2\frac{3}{4}}{4}$ „

„ $\frac{5}{5}$ in $\frac{2\frac{3}{4} \times 9}{4} = 6$ days.

B can do $\frac{1}{6}$ in $4\frac{1}{2}$ days.

∴ „ $\frac{1}{6}$ in $\frac{4\frac{1}{2}}{3}$ „

„ $\frac{6}{6}$ in $\frac{4\frac{1}{2} \times 5}{3} = 7\frac{1}{2}$ days.

A can do $\frac{1}{6}$ in 1 day.

B „ $\frac{1}{7\frac{1}{2}}$ or $\frac{2}{15}$ in 1 day.

A + B can do $\frac{1}{6}+\frac{2}{15} = \frac{5+4}{30} = \frac{9}{30} = \frac{3}{10}$ in 1 day.

Time for A and B to do $\frac{3}{10} = 1$

„ „ $\frac{1}{10} = \frac{1}{3}$

„ „ $\frac{10}{10} = \frac{10 \times 1}{3} = 3\frac{1}{3}$ days. Ans.

FEMALES.

1. Find by practice how much the assets of a bankrupt amount to if his debts are £9,285, and he can pay 17s. 11½d. per £.

9,285 @ 17s. 11½d. each.

	£	s.	d.			
10s. = ½ of a £	9285	0	0	= Amount at	£1	per £.
5s. = ¼ of 10s.	4642	10	0	= „	10s.	„
2s. 6d. = ⅛ of 5s.	2321	5	0	= „	5s.	„
5d. = ⅓ of 2s. 6d.	1160	12	6	= „	2s. 6d.	„
½d. = 1/10 of 5d.	193	8	9	= „	5d.	„
	19	6	10½	= „	½d.	„
	£8337	3	1½	= „	17s. 11½d.	per £.

2. A farmer left his children a sum of money which was the least number of pounds that could be divided by 24, 27, 28, 32, 36, and 56. Find the sum.

Amt. left = L.C.M. of 24, 27, 28, 32, 36, 56.

4 | 24, 27, 28, 32, 36, 56

2 | 6, 27, 7, 8, 9, 14

3, 27, 4, 7

L.C.M. $= 4 \times 2 \times 27 \times 4 \times 7 = 6048$

£6,048 = sum left. Ans.

3. Simplify $\frac{1}{3\frac{1}{3}} - \frac{2\frac{1}{2}}{9} + \frac{3\frac{5}{8}}{2} + \frac{\frac{5}{7}}{4\frac{4}{7}}$.

$\frac{1}{3\frac{1}{3}} - \frac{2\frac{1}{2}}{9} + \frac{3\frac{5}{8}}{2} + \frac{\frac{5}{7}}{4\frac{4}{7}}$

$= \frac{3}{10} - \frac{1}{4} + \frac{29}{16} + \frac{1}{8}$

$= \frac{5-4+29+2}{16}$

$= \frac{32}{16}$

$= 2$. Ans.

4. Make out in proper form a bill for—

21½ lbs. of bacon at 10½d. per lb.
13 „ ham at 11d. per lb.
8½ „ cheese at 1s. 1½d. per lb.
3½ doz. eggs at 7 for 6d.
¼ cwt. of rice at £1 13s. 3d. per cwt.
and 4½ stones of currants at 3d. per lb.

Civil Service Supply Stores,
London, S.W., 15th Jan., 1885.

Mrs. Morton.

Bought of CIVIL SERVICE SUPPLY CO., LIMITED.

	£	s.	d
21½ lbs. of bacon at 10½d. per lb.	0	18	9⅜
13 „ ham at 11d. per lb.	0	11	11
8½ „ cheese at 1s. 1½d. per lb.	0	9	6¾
3½ doz. eggs at 7 for 6d.	0	3	0
¼ cwt. rice at £1 13s. 3d. per cwt.	0	8	3¾
4½ stones currants at 3d. per lb.	0	15	9
	£3	7	4½

Received same time
J. Low,
For C. S. S. Co. LIM.

Grammar.

MALES AND FEMALES.

1. Parse the following sentence:—

'Why did you not do what I bade you?'

Why—an interrog. adv., qual. *did do.*
did—aux. verb to 'do,' irreg. trans., indicating past tense and completing neg. form of verb.
you—pers. pro., com. gen., plur. num., 2nd pers., nom. to *did do.*
not—adv. of mood (negation), qualifying *did do.*
do—irreg. trans. verb, act., inf., pres., gov. by *did.*
did do—irreg. trans. verb, act., ind., past, plur., 2nd, agreeing with its nom. *you.*
what—comp. rel. pro., = that which; *that*—neut., 3rd, sing., obj., gov. by *did do*; *which*—neut., 3rd, sing., obj., gov. by *to do*, und.
I—pers. pro., com. gen., 1st sing., nom. to *bade.*
bade—irreg trans. verb, act., ind., past, 1st, sing., agreeing with its nom. *I.*
you—pers. pro., com. gen., 2nd, plur., obj., gov. by *bade.*

2. What is an affix? Give as many affixes as you can which are used in forming English nouns, with examples.

An affix is a syllable added after a root, as bond—bond-*age.*

The principal affixes used in forming English nouns are:—

-Ar, as beg-g-ar; *-er*, read-er; *or*, sail-or; *-yer* or *ier*, saw-yer, cloth-ier; *-en*, vix-en; *-ard* or *art*, as lag-g-ard, brag-g-art; *-ster*, song-ster; *-dom*, king-dom; *-ship*, friend-ship; *-hood*, girl-hood; *-ness*, dark-ness; *-th*, steal-th; *-y*, beggar-y; *-ery*, mock-ery; *-ric*, bishop-ric; *-lock*, wed-lock; *-ledge*, know-ledge; *-ing*, read-ing.

3. Analyse the following lines:—

Come to the sunset tree!
The day is past and gone;
The woodman's axe lies free,
And the reaper's work is done.

SUBJECT.	PREDICATE.	OBJECT.	EXTENSION.
[Thou]	come	...	to the sunset tree (place)
The day	is past	...	
(and) [it]	[is] gone	...	
The woodman's axe	lies	...	free (manner)
(and) the reaper's work	is done	...	

4. What is a relative pronoun?

Give examples and sentences in which they are used.

A relative pronoun is one which not only stands for a noun, but relates to some noun or pronoun already used, and which is called its antecedent.

The relative pronouns are *who*, *which*, *what*, and *that*, and their compounds.

Examples: That is the man who called you.
I saw the house which you built.
The horse that I bought has broken its leg.
Ask him what he wants.

Geography.

(*Answer Q. 1 or Q. 2; not both.*)

1. Draw a map of Australia, marking the chief physical features only.

2. Describe the mountain system of Scotland.

Scotland is divided into the Highlands and Lowlands. The Highlands may be divided into two divisions, the Northern Highlands and the Grampians. The former lie N. and W. of a line drawn from the Moray Firth to the Firth of Lorne through Glenmore, Ben Attow, Ben Wyvis, and Ben More being the chief heights. The Grampians lie E. of this line, and have Ben Nevis, Macdhui, Cairngorm, and Cairntoul as the principal heights.

A second line drawn from Arran in the W. to Buchan Ness in the N. Sea may be said to divide the Grampians from the Lowlands. South of this line are the Ochil and Sidlaw Hills, near the Tay, the Campsie Fells near the Forth and Clyde, and the Lowther, Pentland, Lammermoor, and Moorfoot Hills, south of these rivers.

3. What do you know of the productions of Canada and the pursuits of the people?

Canada may be said to be a new country. Its vast extent is very largely covered with forests, chiefly of pine. The soil is extremely fertile, and the people are therefore engaged chiefly in pursuits which follow from these facts. Many are engaged in cutting down timber and preparing it for export, either in logs, or sawn, or as ash. Others are engaged in agriculture, wheat, barley, oats, maize, hemp, flax, and tobacco being largely grown. Besides pine the forests produce oak, maple, elm, birch, walnut, beach, and cedar. The mineral wealth of Canada is also very great, but the mines are not yet largely developed. Gold, iron, silver, copper, lead, and zinc are abundant. The fisheries of the eastern part of the Dominion are very important, employing large numbers of people, especially in Newfoundland.

History.

1. Name the different nations or tribes which conquered England at different times from its earliest-known history to the Norman conquest, with dates.

England was first conquered by the *Romans*, being invaded by Julius Cæsar in 55 and 54 B.C., and by Claudius in 43 A.D. The Roman occupation lasted till 410 A.D., and during the next forty years the *Picts and Scots* from Caledonia invaded the northern parts. These were driven back by the *Teutons* who were invited over by the British for that purpose. Various tribes of these, including *Saxons*, *Jutes*, *Angles*, and *Frisians*, came over at different times from 450 to 582 A.D. The country was again invaded by *Danes* from Norway, Sweden, and Denmark, at various times from 787 to 1014.

2. What led to the peace of Wedmore? Who were the parties engaged in the battle of Ethandune, and what were its results?

The battle of Ethandune was fought between the Danes under Guthrum and the English under Alfred. Alfred had visited the Danish camp, and gathering his forces had attacked them at the above place, and gave them such a beating that they were glad to yield to him. The Witan was then meeting at Wedmore, and a treaty was signed by which the Danes received East Anglia and part of Mercia, and Guthrum consented to receive Christian baptism.

3. Who was Dunstan? Give a short account of his life.

Dunstan was a monk who was made Abbot of Glastonbury by Edmund. In Edwy's reign differences arose respecting the secular clergy, who were often married, despite the prevalent opinion that the clergy ought not to marry. Dunstan took the part of the monks, and in consequence of his opposition to the king's marriage was driven out of the country. A revolt against Edwy, and the succession of Edgar led to Dunstan's return. He became Archbishop of Canterbury, and the chief counsellor to the king. Under his guidance the country was well governed. He died A.D. 989.

Composition.

Write from memory the substance of the following story:—

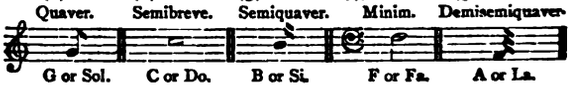
Two boys chanced to stray into the kitchen of a public-house. They found a large blazing fire and a box containing, according to the inscription, a Welsh dwarf; but there was not a person in the room besides. The boys eager to see the dwarf, but unable or unwilling to pay for the sight, began to consult how they should strive to obtain a view. They could not carry the box away, and the lock being on the inside they could not force it. At last they hit upon an ingenious stratagem. By joint efforts they pushed the box so near the fire that the dwarf, from the increased heat, was obliged to open the door and favour them *gratis* with his wished-for presence.

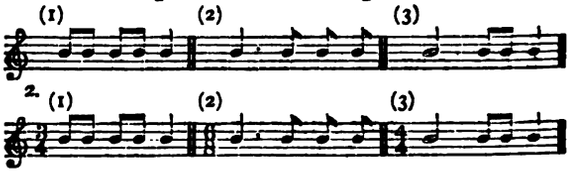
Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write above each of the following notes its value-name (crotchet, &c.), and below each its pitch-name (A or La, &c.):—

1. (1) (2) (3) (4) (5)

2. Add time-signatures to the following:—



3. Write below each of the following intervals its name (major fourth, &c.):—

3.

TONIC SOL-FA NOTATION.

1. What are the measures commonly used? Write (*a*) a four-pulse tone, using two-pulse measure; and (*b*) a six-pulse tone, using three-pulse measure.

1. Two-pulse, three-pulse, four-pulse, six-pulse, and nine-pulse.

(*a*) |l :— |— :— ‖ (*b*) |l :— :— |— :— :— ‖

2. Write down the names of the following intervals:—(1) *te* to *doh*; (2) *soh* to *ray*^{1}; (3) *fah* to *fah*^{1}.

2. (1) Minor second; (2) major or perfect fifth; (3) octave or eighth.

3. Write the following an octave lower, and explain the meaning of "Key F":—

Key F.
|m :d :r |s :d^{1} :l |s :— :— ‖

3. Key F.
|m$_{1}$:d$_{1}$:r$_{1}$ |s$_{1}$:d :l$_{1}$ |s$_{1}$:— :— ‖

"Key F" means that *doh* of the music is to be fixed to the particular sound of the scale called "F."

SECOND YEAR.

Pupil Teachers at end of Second Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for words may be used.]

1. To draw a straight line at right angles to a given straight line from a given point in the same.

What is the corollary that can be demonstrated by the aid of this proposition?

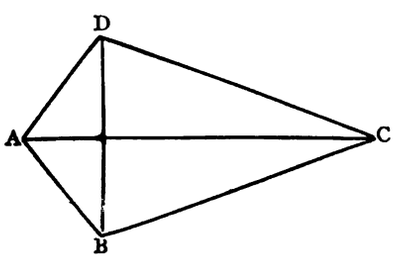
Euclid, Book I., Prop 11.

That two straight lines cannot have a common segment.

2. Any two sides of a triangle are together greater than the third side.

Euclid, Book I., Prop. 20.

3. The four sides of any quadrilateral are together greater than the two diagonals together.



Let ABCD be a quadrilateral, and AC and BD the two diagonals. The four sides AB, BC, CD, DA together are greater than BD and AC together.

The sides BA, AD are > BD in the $\triangle$ BAD (I. 20), and the sides BC, CD are > BD in the $\triangle$ BCD (I. 20).

Again: the sides AD, DC are > AC in the $\triangle$ ADC (I. 20), and the sides AB, BC are > AC in the $\triangle$ ABC (I. 20).

$\therefore$ twice AB, BC, CD, DA are together > than twice AC, BD; and AB, BC, CD, DA are together > than AC, BD.

Q. E .D.

Arithmetic.

FEMALES.

1. Add $\frac{3}{4}$ of £1, $\frac{8}{9}$ of £1 7s, 9d., and $1\frac{3}{5}$ of £10.

	£	s.	d.
$\frac{3}{4}$ of £1 $= \frac{3}{4} \times \frac{20}{1} =$	0	15	0
$\frac{8}{9}$ of £1 7s. 9d. $= \frac{8}{9} \times \frac{141}{4} = \frac{94}{3}$s. $=$	1	4	8
$1\frac{3}{5}$ of £10 $= \frac{8}{5} \times \frac{10}{1} = 16 =$	16	0	0
	17	19	8

Ans.

2. Express $\frac{8}{111}$ and $7\frac{1}{9}$ as decimals.

$\frac{8}{111} = \frac{1}{111} = \underline{.036}$. Ans.

$7\frac{1}{9} = 7{\cdot}1$. Ans.

3. Reduce 18s. $1\frac{1}{2}$d. to the fraction of £1, and multiply the answer by $5\frac{1}{20}$.

$$\frac{\text{s. d.}}{\pounds 1} \quad 18\ 1\tfrac{1}{2} \times 5\tfrac{1}{20}$$
$$= \frac{145}{160} \times \frac{101}{20}$$
$$= \frac{29}{32} \times \frac{101}{20}$$
$$= \frac{2929}{640}$$
$$= 4\frac{289}{640}. \text{ Ans.}$$

4. A father left £140 less than one half of his money to his eldest son, £20 and a quarter of his money to the second, £220 less than $\frac{1}{8}$ to his youngest son, and $\frac{1}{8}$ to his wife. Find what he left and the eldest son's share.

Total money left

£
$= \frac{1}{2} - 140$ to eldest son
$\frac{1}{4} + 20$,, second ,,
$\frac{1}{8} - 220$,, youngest son
$\frac{1}{8}$,, wife
$= \frac{7}{8} - 340$
$\therefore \frac{1}{8} = 340$
$\frac{1}{80} = 20$
$\frac{80}{80} = \underline{\pounds 1200}$. Ans.

$\frac{1}{2}$ of £1200 $- 140 = \underline{\pounds 460}$. Ans.

Grammar.

MALES AND FEMALES.

1. Analyse the following passage, and parse fully the words in italics:—

To work when others are *idle will enable* you *to be* idle when *others* are at work.

(*a*) ANALYSIS.

Sentence.	Kind of Sentence.	Conn.	Subject.	Predicate.	Object.	Exten.
(*a*) To work will enable you to be idle	Principal Sentence.		To work	will enable	you (dir.) to be idle (indir.)	
(*b*) when others are idle	Adv. Sent. (time) to 'to work' in *a*.	when	others	are idle		
(*c*) when others are at work	Adv. Sent. (time) to 'to be idle' in *a*	when	others	are at work		

(*b*) *To*—particle, sign of inf. mood.
to work—reg. trans. verb, act., inf., used as abstract noun, neut., sing., 3rd, nom. to 'will enable.'
when—adverbial cop. conj. joining the sentences, '*If you* work' and 'others are idle.'
idle—adj. of quality, qualifying 'others.'
will—aux. verb to 'enable,' indicating future tense.
enable—reg. trans. verb, act., inf., pres., gov. by 'will.'
will enable—reg. trans. verb, act., ind., pres., 3rd, sing., agreeing with its nom. 'to work.'
to be—irreg. intrans. verb, act., inf., pres., gov. by 'will enable.'
others—indef. pers. pro., com., plur., nom. to 'are.'

2. Give the full force of the prefixes and the meaning of the following words:—

Controvert, efface, irresistible, invaluable, pollute, purpose, succumb.

Word.	Prefix.	Meaning.
Controvert	contro-	against; to turn against
Efface	ef-	out; to destroy the face, to rub out
Irresistible	ir-	not; not to be resisted
Invaluable	in-	not; not admitting of being valued
Pollute	pol-	towards; to wash towards, to defile
Purpose	pur-	forward; to place forth, to intend
Succumb	suc-	under; to lie down under

3. Paraphrase

Prepare you, generals:
The enemy comes on in gallant show;
Their bloody sign of battle is hung out
And something to be done immediately.

Generals! it is necessary that you should get ready for battle immediately. Our enemies are approaching us in all the glory of battle array; their ensigns declaring their intention to fight float in the breeze, and an attack will at once take place.

Geography.

1. Draw a map of India inserting the physical features and the chief towns.

2. Name the chief European seaports of the Mediterranean and the Baltic Seas, with their principal exports.

The chief ports of the Mediterranean are Barcelona, Marseilles, Genoa, Civita Vecchia, Leghorn, Naples, Palermo, Brindisi, Venice, Trieste, Syra, Nauplia, Hydra, Constantinople, Gallipoli, Saloniki; and the exports are silk, wool, dried and other fruits, raw cotton, olive oil, quicksilver, lead, glass, marble, straw hats, brimstone.

The chief ports of the Baltic are St. Petersburg, Riga, Dantzic, Konisberg, Stettin, Memel, Lubeck, Copenhagen, Christiania, Stockholm, Christiansand, and Gottenburg; and the exports are tallow, wheat, timber, hemp, potash, wool, corn, linen, flax, cattle, hides, provisions, tar, and iron.

3. What are the climatic advantages which New Zealand claims over Queensland and Canada as a settlement for people from this country.

A great part of Queensland is situated within the tropics. The heat, therefore, is intense, and to persons born and reared in this country the climate is, especially in the north, somewhat trying. Droughts also are frequent.

Canada, on the other hand, is very much colder than the British Isles; the winters are longer and much more severe, although the atmosphere is drier than that of this country.

The climate of New Zealand resembles that of this country, and a colonist settling there experiences little change, except that the winters are not so cold. Wind and rain are more prevalent, but the variations of temperature are less numerous. The amount of rainfall is greater, but the number of rainy days is less.

The chief climatic advantages of New Zealand are therefore those which are derived from the small amount of change from the climate of this country.

SECOND PAPER.

Two hours and a half allowed.

FEMALES.

(One hour allowed for the needlework specimens.)

Arithmetic.

MALES.

1. What percentage is a farthing of (*a*) a pound, (*b*) of a shilling, (*c*) of a penny, and 3 ozs. of a quarter?

$\frac{1}{4}$d. $= \frac{1}{960}$ of £1 or $\frac{1}{960}$ of £100 $=$ ·1041̇6 p. c.

$\frac{1}{4}$d. $= \frac{1}{48}$ of 1s. or $\frac{1}{4800}$ of 100s. $=$ 2·08$\frac{1}{3}$ p. c.

$\frac{1}{4}$d. $= \frac{1}{4}$ of 1d. or $\frac{1}{400}$ of 100d. $=$ .25 p. c.

3 ozs. $= \frac{3}{112}$ of 1 qr. or $\frac{3}{11200}$ of 100 qr. $=$ ·669.. p. c.

2. In what time will £120 amount to 120 guineas at $3\frac{1}{2}$ per cent. per annum simple interest?

In one year £120 at $3\frac{1}{2}$ will yield $\frac{120 \times 3\frac{1}{2}}{100} = £4$.

Total interest to make = 120 guineas − £120
= 120s. = £6.

∴ Time required = 4 : 6 :: 1 : x
= $1\frac{1}{2}$ years. Ans.

3. A grocer, having bought 500 lbs. of rice, sells $8\frac{1}{2}$ per cent. of the quantity to X, 140 lbs. to Y, and $2\frac{1}{2}$ per cent. of the remainder to Z. What quantity has he left, and what is its value at 1s. 8d. a stone?

		lbs.
Amount sold to $X = \frac{8\frac{1}{2}}{100}$ of 500	=	$42\frac{1}{2}$
,, ,, Y	=	140
,, left = 500 − ($42\frac{1}{2}$ + 140)	=	$317\frac{1}{2}$
,, sold to $Z = \frac{2\frac{1}{2}}{100}$ of $317\frac{1}{2}$	=	7·9375
,, left = 317·25 − 7·9375	=	309·3125. Ans.

Value $= \frac{309 \cdot 3125 \times 20}{14} =$ £1 16s. $9\frac{1}{2}$d. Ans.

4. At what price must I sell out £5400 stock, which cost me $75\frac{1}{2}$ per £100 stock, in order to gain $7\frac{1}{2}$ per cent. on my outlay?

Cost price of stock = $75\frac{1}{2}$ per £100 stock.
Required gain = $7\frac{1}{2}$ p. c.
∴ gain on $75\frac{1}{2} = \frac{75\frac{1}{2} \times 7\frac{1}{2}}{100} = 5 \cdot 6625$.

Selling price per £100 stock = C. P. + gain
= $77\frac{1}{2} + 5 \cdot 6625$
= 81·1625
= £81 3s. 3d. Ans.

History.

1. Relate briefly the historical events connected with the following places with dates:—Blackheath, Leicester Abbey, Norwich Castle, Smithfield, Fotheringay Castle.

In 1497, a rising in favour of Perkin Warbeck took place in Cornwall. A force of 16,000 marched to *Blackheath*, where they were attacked by Henry VII.'s forces, and 2000 of them slain.

Wolsey, after having incurred the displeasure of Henry VIII., retired to York, but was arrested in 1530 for high treason. On his way to trial he was taken ill, and died at *Leicester Abbey*.

During the reign of Edward VI., a rebellion in Norfolk, under Ket, a tanner, took place in 1550. It was put down by the Earl of Warwick, and Ket was hanged on the walls of *Norwich Castle*.

Smithfield is associated with the burning of Protestants chiefly in 1555, in the reign of Queen Mary. In Smithfield Wat Tyler was killed, 1381.

Fotheringay Castle is noted as the place of imprisonment and execution of Mary Queen of Scots, 1587.

2. What additions were made to the geographical knowledge of the people during the reign of Henry VII.?

During the reign of Henry VII., Columbus discovered the Bahamas, a group of islands in the West Indies, in 1492; Sebastian Cabot discovered Newfoundland, and the mainland of America, in 1497; while in 1486, Bartholomew Diaz doubled the Cape of Good Hope, thus discovering an ocean route to the East Indies.

3. What was the origin of the Crusades? How came the Kings of England to engage in them? Give the dates of the First and Second Crusades.

Peter, the Hermit of Amiens, witnessed the cruelties practised upon the Christians by the Turks in Palestine. On his return he complained to Pope Urban II., and under his sanction, a general crusade was preached throughout Europe, the First Crusade starting in 1095. Robert of Normandy, brother of William II., joined this Crusade, to vie with the other nobles of Christendom in the zeal for the recovery of the Holy Sepulchre. The Second Crusade took place in 1146. Richard I. joined the Third Crusade in his ardent zeal for the honours of chivalry. Edward I. joined the Fourth Crusade in imitation of Philip of France.

Teaching.

State the methods you employ in teaching children in Standard I. how to write neatly and correctly on slates.

Slates are ruled for text-hand and a large small-hand. I first find out what the children can do in the formation of letters. If they have been in the infant school, they can do these fairly well, but if in different schools, letters may be made in different ways. To secure uniformity, I give patterns on the blackboard. Next, examine quickly, and point out errors. Then, in the

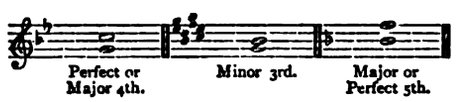
combination of letters, I follow the same plan. After seeing that the forms of the letters are known, a lesson in transcription is given, and individual errors are pointed out. The position of the body, seat, and slate, and the holding of the pencil are carefully attended to. After lessons in transcription come easy lessons in dictation. Then they alternate.

Music.

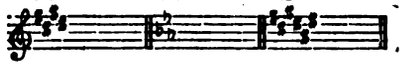
A quarter of an hour allowed for this paper.

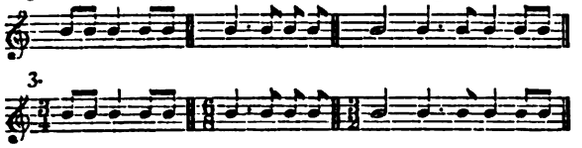
(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write below each of the following intervals its name (major second, &c.) :—

1.

2. Write the key-signature of each of the following major keys :—(1) of E ; (2) of A♭ ; (3) of F♯.

2. (1) (2) (3).



3. Add time-signatures to each of the following :—

3.

TONIC SOL-FA NOTATION.

1. What are the mental effects of (*a*) *soh* ; (*b*) *doh* ; (*c*) *me*?

1. (*a*) Grand and bright ; (*b*) firm and bold ; (*c*) calm and steady.

2. What are the names of the following intervals :—(1) *lah* to *ray*' ; (2) *me* to *soh* ; (3) *fah* to *doh*' ?

2. (1) Major or perfect fourth ; (2) minor third ; (3) major or perfect fifth.

3. Write (1) a nine-pulse tone in a three-pulse measure ; and (2) an eight-pulse tone in a four-pulse measure.

3. (1) |1 :— :— |— :— :— |— :— :— ‖

(2) |1 :— |— :— |— :— |— :— ‖

THIRD YEAR.

Pupil Teachers at end of Third Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

Answer two Questions, including No. 3, if you can.

1. The complements of the parallelograms, which are about the diagonal of any parallelogram, are equal to one another.

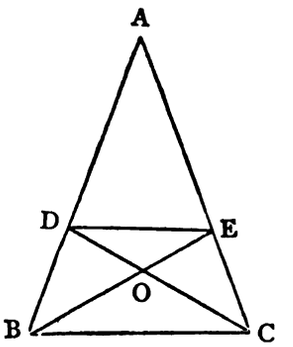
Euclid, Book I., Prop. 43.

2. To describe a square upon a given finite straight line.

Euclid, Book I., Prop. 48.

3. The angles ABC, ACB of an isosceles triangle are bisected by straight lines which meet AB, AC, at D and E respectively. Show that DE is parallel to BC.

Let the straight lines BE, CD bisect the ∠s ABC, ACB of the isosceles △ ABC, and meet AB, AC in D and E. Then DE is parallel to BC.



The ∠ ABC = ∠ ACB (Hyp.) and ∠ DBE = ∠ ECB, for they are halves of equal ∠s.

∴ ∠ OBC = ∠ OCB, and side OB = side OC (I. 6),

And the ∠ BOD = ∠ COE (I. 15),

∴ in △s DBO, ECO, the two ∠s DBO, BOD = two ∠s ECO, COE, and side BO = side CO.

∴ side OD = side OE (I. 26).

∴ ∠ ODE = ∠ OED (I. 6).

∴ ∠ DOE = ∠ BOE (I. 15), and the three interior ∠s of a △ are = two right ∠s.

∴ sum of ∠s = ODE, OED = sum of ∠s OBC, OCB.

∴ (Ax. 7) ∠ DEO = ∠ EBC. And they are alternate ∠s.

∴ (I. 29) DE is parallel to BC.

Q. E. D.

Algebra.

(*Answer two Questions, including No. 3, if you can.*)

1. Find the value of x in the following example :—

$$\tfrac{1}{17}(2x+7)-\tfrac{1}{18}(2x-7)=1\tfrac{1}{2}-\tfrac{1}{18}(3x+4)$$

$$\tfrac{1}{17}(2x+7)-\tfrac{1}{18}(2x-7)=\tfrac{3}{2}-\tfrac{1}{18}(3x+4)$$

$$20(2x+7)-36(2x-7)=990-27(3x+4)$$

$$40x+140-72x+252=990-81x-108$$

Collecting and transposing

$$49x=490$$

$$x=10$$

2. Resolve (*a*) $3(x^2-y^2)-5(x-y)^2$; (*b*) $a^3-b^3-3ab(a-b)$; and (*c*) $(x+y)^2+2(x^2+xy)-3(x^2-y^2)$ into elementary factors.

(*a*) $3(x^2-y^2)-5(x-y)^2$

$=3x^2-3y^2-5x^2+10xy-5y^2$

$=-2x^2-8y^2-10xy$

$=2(-x^2-4y^2-5xy)$

$=\underline{2(-x+4y)(x-y)}$

(*b*) $a^3-b^3-3ab(a-b)$

$=a^3-b^3-3a^2b+3ab^2$

$=\underline{(a-b)^3}$

(*c*) $(x+y)^2+2(x^2+xy)-3(x^2-y^2)$

$=x^2+2xy+y^2+2x^2+2xy-3x^2+3y^2$

$=4xy+4y^2$

$=\underline{4y(x+y)}$.

3. Write down in words some of the common results in multiplication and division of algebraic examples.

In multiplication :—

The square of the sum of two quantities (a binomial) is equal to the sum of their squares plus twice their product.

The square of the difference of two quantities is equal to the sum of their squares minus twice their product.

The product of the sum and difference of two quantities is equal to the difference of their squares.

In division :—

If the index be odd x^n+y^n is divisible by $x+y$

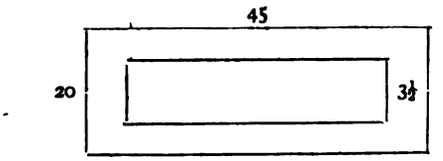
,, ,, x^n-y^n ,, ,, $x-y$

If the index be even x^n+y^n is divisible by neither $x+y$ nor $x-y$

,, ,, x^n-y^n is divisible by both.

Mensuration.

A road $3\frac{1}{2}$ yds. wide was made round a rectangular piece of ground, the sides of which were 45 and 20 yds. respectively, what did it cost at 1s. 9d. per sq. yd.?



Total area of ground
$= 45 \times 20 = 900$ sq. yds.
Area of ground inside the walk
$= (45-7)(20-7) = 494$ sq. yds.
$\therefore$ Area of walk $= 900 - 494 = 406$ sq. yds.
Cost of road $= 406 \times$ 1s. 9d.
$=$ £35 10s. 6d. Ans.

Arithmetic.

FEMALES.

1. Reduce $3\frac{1}{2}$ in. to the decimal of a quarter of a mile, and £2 11s. $6\frac{3}{4}$d. to the decimal of £5.

$$\frac{3\frac{1}{2}\text{ in.}}{\frac{1}{4}\text{ mile}} = \frac{3\frac{1}{2}\text{ in.}}{440\text{ yds.}} = \frac{3\frac{1}{2}\text{ in.}}{15840} = \frac{1}{4528} = .00022095.\quad \text{Ans.}$$

4	3
12	6·75
20	11·5625
5	2·578125
	·515625 Ans.

2. Find the values of $3{\cdot}5 + 2{\cdot}8\dot{3} + {\cdot}\dot{6} + 1{\cdot}175$; $11{\cdot}7\dot{3} - 10{\cdot}9\dot{1}\dot{6}$; $3{\cdot}375 \times 1{\cdot}\dot{6} \times 4{\cdot}8$; $\frac{3{\cdot}375}{4{\cdot}5}$.

3·5	11·7333
2·8333	10·9166
·6666	·816. Ans.
1·175	
8·1749 Ans.	

$3{\cdot}375 \times 1{\cdot}\dot{6} \times 4{\cdot}8$
$= 3\frac{3}{8} \times 1\frac{2}{3} \times 4\frac{4}{5}$
$= \frac{27}{8} \times \frac{5}{3} \times \frac{24}{5}$
$= 27$. Ans.

$\frac{3{\cdot}375}{4{\cdot}5}$
$= \frac{{\cdot}675}{{\cdot}9}$
$= {\cdot}75.$ Ans.

3. A bankrupt's debts amounted to £980, and his creditors received 13s. 6d. in the £; what was the value of his effects?

£	£		s. d.	£ s.
1	: 980	::	13 6	: 661 10. Ans.

4. A person sold ·15 of an estate to one person, and then $\frac{8}{17}$ of the remainder to another person. What part of the estate did he keep?

Total estate	= 1
Amount sold	= ·15
Amount left	·85
2nd Amt. sold $= \frac{8}{17}$ of ·85	= ·25
Amount he kept	·60 or $\frac{3}{5}$. Ans.

Grammar.

MALES AND FEMALES.

1. Analyse the following passage, and parse the words in italics :—

Hail, beauteous stranger of the grove!
Thou messenger of spring!
Now Heaven repairs thy rural seat,
And *woods* thy *welcome sing*.
What time the daisy decks the green,
Thy certain voice we hear;
Hast thou a star *to guide* thy path,
Or *mark* the rolling year?

LOGAN.

ANALYSIS.

Sentence.	Kind of Sentence.	Connective.	Subject.	Predicate.	Object.	Extensn. of Pred.
Hail, beauteous stranger of the grove, thou messenger of spring			*Nom. of address*			
(a) Now Heaven repairs thy rural seat	Princ. Sent.		Heaven	repairs	thy rural seat	now (time
(b) And woods thy welcome sing	Princ. Sent. co-ord. with (a)	And	woods	sing	thy welcome	
(c) the daisy decks the green	Adj. Sent. to *time* in (d)		the daisy	decks	the green	
(d) thy certain voice we hear what time	Princ. Sent.		we	hear	thy certain voice	[on] what time (time)
(e) Hast thou a star to guide thy path	Princ. Sent.		thou	hast	a star [dir.] to guide thy path [ind.]	
(f) or mark the rolling year.	Princ. Sent.	or	[thou]	[hast]	[a star] to mark the rolling year [ind.]	

Thou—Per. pro., com., sing., 2nd, nom. of address, in app. with 'stranger.'
messenger—com. noun, com., sing., 2nd, nom. of address, in app. with 'stranger.'
woods—com. noun, neut., plur., 3rd, nom. to 'sing.'
welcome—abs. noun, neut., sing., 3rd, obj., gov. by 'sing.'
sing—irreg. trans. verb, act., ind., pres., plur., 3rd, agreeing with its nom. 'woods.'
what—rel. pro., used as adj., qualg. 'time.'
time—abs. noun, neut., sing., obj., gov. by 'at,' und.
hast—irreg. trans. verb, act., ind., pres., 2nd, sing., agreeing with its nom. 'thou.'
to guide—reg. trans. verb, act., inf., pres., gov. by 'hast.'
mark—reg. trans. verb., act., inf., pres., gov. by 'hast,' understood.

2. Paraphrase the above passage :—

I bid thee hail! thou lovely tenant of the woods and welcome harbinger of spring! Returning warmth has clothed in green thy country home, and trees and groves rejoice at thy approach. When the flowers first deck the fields we are sure to hear thy voice. How findest thou thy way across the sea? Is there some star to tell thee of the changing year, or guide thee safely back?

3. Name some of the affixes in geographical names which are not of English origin, with examples of their use.

Ark—an altar, as Grimsargh.
beck—a brook, as Wansbeck, Troutbeck.
by—a town, as Whitby, Grimsby.
dal—a dale or valley, as Teesdale.
ey—an island, as Orkney, Sheppey.
fell—a hill, as Scafell, Snaefell.
ford—an arm of the sea, as Milford.
garth—a field, an enclosure, as Applegarth.
gate—a way or passage, as Westgate.
holm—an island, as Bornholm.
kirk—church, as Ormskirk.
force—a waterfall, as High Force.

4. Give examples of Keltic words introduced into English in modern times.

Shamrock, reel, strathspey, brogue, clan, claymore, plaid, pibroch, whiskey

Geography.

MALES.

(*Answer Two Questions.*)

1. Draw a map of Egypt and the Soudan.

2. Describe the mountain system of Asia.

The great watershed of Asia stretches rom N.E. to S.W., through the whole continent. The northern slope is the great plain of Siberia; the southern slope is diversified by extensive plateaus and lofty mountain range , intersected by deep valleys. The principal ranges stretch in a westerly, south-easterly, and north-easterly direction from the Bolor Tagh Mts., which reach 19,000 feet in height. The principal ranges to the west are Hindoo-koosh, Paropamisna, Elburz, Mts. of Armenia, Taurus, Anti-Taurus, and Lebanon. To the south-east there are the Himalayas, the loftiest mts. in the world, Mt. Everest being 29,000 feet high; the Karakorum Mts in Thibet, the Mts. of Aracan and Cambodia, and the lesser ranges, Vindhya, Ghauts, Neilgherries in Hindustan. Stretching to the N.E. there are the Kuen-Lun, the Pe-ling, Thian Shan, Altai, and Yablonoi Mts., and the Aldan Mts. in the extreme east of Siberia.

In these ranges there are many lofty peaks, and the mountain system of Asia raises the average height of surface of the continent of Asia much above that of the other continents. The mountains are the sources of many large rivers.

3. What accounts for the dryness of the climate and the general sterility of a great part of Africa?

The greater part of Africa is situated within the tropics. It has few mountains, and those which it has are situated near the coast. Its coast is very little indented. As the land receives so much heat, and there are no mountains whose cold summits would condense the vapours carried over the country from the oceans, the air instead of being chilled is heated as it passes over the country, and its capacity for holding moisture is increased. There is, therefore, little rain, and the climate is dry. The absence of moisture and the nature of the surface, which is made up in great part, especially in the north, of sand and salt, accounts for the sterility of the soil.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

(*One hour is allowed for the Exercises in Needlework.*)

Arithmetic.

MALES.

1. The retail price of a book is 5s. If the expenses of sale were 15 per cent. and the profits 25 per cent. on the cost price, what was the original cost of the book?

C. P. + exp. + gain = Retail price.
100 + 15 + 25 = 5s.
140 = 5s.
1 = $\frac{5}{140}$
100 = $\frac{5 \times 100}{140}$
= 3s. 6$\frac{3}{7}$d. Ans.

2. The sides of a triangular field which contain a right angle are 750 and 625 links respectively, what is the length in chains of the third side?

$(750^2 + 625^2) = (562500 + 390625) = 953125$
$\sqrt{953125} = 976{\cdot}27 +$ links
$= 9{\cdot}7627 +$ chains. Ans.

3. A man left ·375 of his estate to one son and the remainder to another. The difference in the value of their legacies was £250. Find the value of the estate.

1 − ·375 = ·625
The diff. in value between ·625 and ·375 is £250
∴ ·25 of estate = £250
And the whole estate = £1000. Ans.

4. Eggs which cost 7½d. per doz. were sold at 16 for a shilling, what was the gain or loss per cent.?

16 for 1s.
1 ,, $\frac{1}{16}$ = $\frac{3}{4}$d.
12 ,, $\frac{3}{4} \times 12$ = 9d. S.P.
∴ Gain on 7½d. = 9d. − 7½d. = 1½d.
And gain per cent. = 7½ : 100 :: 1½ : 20. Ans.

History.

MALES AND FEMALES.

1. What led to the Act of Settlement? What were its provisions, and when did it become law?

William III. and Mary II. were without issue, and on the death of the Duke of Gloucester, the last surviving child of the Princess Anne (afterwards Queen), it became necessary to provide for a Protestant successor to the throne, and so exclude the Pretender and his descendants. It provided that the crown, in default of issue of William and Anne, should pass to Sophia of Hanover and her descendants; that the successor to the throne should be in communion with the Church of England; that England should not engage in war on behalf of the foreign possessions of its king without the consent of Parliament; that the Sovereign should not leave Great Britain or Ireland without the consent of Parliament; that the judges should retain office during good behaviour; and that no person in the service of the Crown should sit in the House of Commons. The Act was passed in 1701.

2. What attempts were made by James II. and his descendants to regain possession of the throne?

After the second flight of James to France, he was invited by Tyrconnel, Lord-lieutenant of Ireland, to that country. Assisted by Louis of France, James went to Ireland in 1689. In Dublin he called a Parliament, and at the head of troops besieged Londonderry for a time. After the relief of Londonderry, the battles of Newton Butler and the Boyne were fought. James was defeated, and fled to France.

In 1715, the son of James, styled the 'Pretender,' attempted to overthrow the Government of George by a rebellion in Scotland. The Earl of Mar first raised the standard of rebellion. The insurgents marched as far south as Preston, where they were compelled to surrender. Another engagement took place at Sheriffmuir, which was undecided, but after which the Highlanders gradually dispersed.

In 1745, the Young Pretender, grandson of James II., also attempted to regain the throne. The rebels gained the battle of Preston Pans, and advanced into England as far as Derby. They were followed to Scotland by the Duke of Cumberland, and defeated at Culloden, after which Charles escaped to the Continent.

3. What were some of the benefits derived by England and Scotland respectively from the Union of the Parliaments of those countries?

England lost a troublesome neighbour, and one which had sometimes been a powerful enemy as the ally of France, and gained a firm friend and useful ally.

Scotland was no longer in danger of ultimate conquest or of ruinous wars as the result of collision with her southern neighbour; her trade and commerce were rapidly developed, and she rapidly increased in wealth and prosperity.

Teach'ng.

Write the notes of a lesson for an upper class on

'THE INFINITIVE MOOD.'

Recapitulate previous lessons on the indicative, and imperative, and subjunctive moods, and show that these are limited by reference to agent or agents, that is, that they have person and number.

Then write sentences on blackboard containing examples of infinitive mood, as 'I love to read,' 'To err is human,' 'I delight to go.'

From these examples show that the verb is used without reference to agents, and so get

(*a*) *Definition.*—The infinitive mood (exp. root, Lat. infinitus, in, finitus, unbounded) is that form of the verb which denotes an action unlimited as regards person and number.

(*b*) *How known.*—Generally by sign 'to.' Show how in O.E. the inf. was a noun and had cases; one, the dative, having 'to' before it, and also different endings. When these were lost, 'to' was used before all the cases.

(*c*) *How used.*—

(1) Along with auxiliaries: as, 'I can go,' 'He should go,' 'I must go.' Show how the sign 'to' is needed if the *meaning* of the auxiliary be substituted, as, 'I can go'='I have the power *to* go.' 'He should go'='He ought *to* go,' etc.

(2) As a noun:
e.g., To return was unwise.
He longed to remain.
I love to read.

(3) To express purpose:
As, He stood up to read.
They went away to catch fish.

(4) To qualify nouns or adjectives:
As, We have a house to dwell in.
He is ready to forgive.

(5) After verbs *make, dare, bid, feel, hear, see,* and *let* without the sign *to.*

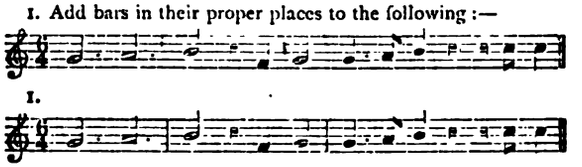
(*d*) Give examples orally and on slate or paper, and have uses pointed out.

Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both.* The questions in the Tonic Sol-fa Notation will be found at the end.)

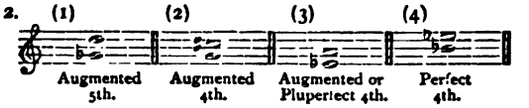
1. Add bars in their proper places to the following:—



1.

2. Write below each of the following intervals its name (minor third, &c.):—

2. (1) (2) (3) (4)



Augmented 5th. Augmented 4th. Augmented or Pluperfect 4th. Perfect 4th.

3. What are the meanings of the following terms:—(*a*) *Largo*; (*b*) *Vivace*; (*c*) *Presto.*

3. (*a*) Very slow; (*b*) very lively; (*c*) very quick.

TONIC SOL-FA NOTATION.

1. Write perfect or major fifths above:—(1) *ray*; (2) *fah*; (3) *lah.*

1. (1) *lah*; (2) *doh*^{1}; (3) *me.*

2. What is the meaning of the following terms:—(*a*) *Largo*; (*b*) *Vivace*; (*c*) *Presto.*

2. (*a*) Very slow; (*b*) very lively; (*c*) very quick.

3. Re-write the following, halving the value of every note and rest, and using two-pulse measure:—

| s :— | m :l | d' :-.t | l :— | : | m :— ‖

3. | s :m.l | d'.,t :l | : m ‖.

FOURTH YEAR.

Pupil Teachers at end of Fourth Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

(*Answer two Questions, including No.* 3, *if you can.*)

1. If a straight line be divided into any two parts, the sqs. on the whole line, and on one of the parts, are equal to twice the rectangle contained by the whole and that part, together with the sq. on the other part.

Euclid, Book II., Prop. 7.

2. To describe a square that shall be equal to a given rectilineal figure.

Euclid, Book II., Prop. 14.

3. Prove the proposition of Euclid given in Question 1 algebraically.

A . C B

Let AB be the given straight line, and let it be divided into any two parts at the point C; the sqs. on AB, BC shall be =twice the rect. AB.BC, together with the sq. on AC.

For let AB contain x linear units, and AC y, and CB z units

Then $x=(y+z)$

and squaring both sides

$$x^2=y^2+2yz+z^2$$

Adding z^2 to each side,

$$\therefore\ x^2+z^2=y^2+2yz+2z^2.$$

But $2yz+2z^2=2(y+z)z$

$$=2xz$$

$$\therefore\ x^2+z^2=y^2+2xz.$$

That is, sq. on AB+sq. on BC
=sq. on AC+twice AB.BC.

Q. E. D

Algebra.

(*Answer two Questions.*

1. Solve (1) $x(y+7)=y(x+1)$
$2x+20=3y+1.$

(2) $ax+by=c^2$
$\frac{a}{b+y}-\frac{b}{a+x}=0.$

(1) $x(y+7)=y(x+1)$
$2x+20=3y+1$
$xy+7x=xy+y$
$2x+20=3y+1$

Collecting and transposing
$7x-y=0$
$2x-3y=-19$
$21x-3y=0$ (I.)
$2x-3y=-19$ (II.)
$19x = 19$
$x=1$

Substituting value of x in (1)
$21-3y=0$
$21=3y$
$y=7.$ $x=1,\ y=7.$ Ans.

(2) $ax+by=c^2$
$\frac{a}{b+y}-\frac{b}{a+x}=0$
$ax+by=c^2$
$a^2+ax-b^2-by=0$
$ax+by=c^2$ (I.)
$ax-by=b^2-a^2$ (II.)
$2ax = -a^2+b^2+c^2$
$x=\frac{-a^2+b^2+c^2}{2a}$ Ans.

Subtracting (II.) from (I.)
$2by=c^2-a^2-b^2$
$y=\frac{c^2+a^2-b^2}{2b}$ Ans.

2. Simplify:—

$$\frac{x-\frac{x-y}{1+xy}}{1+\frac{x(x-y)}{1+xy}}$$

$$\frac{x-\frac{x-y}{1+xy}}{1+\frac{x(x-y)}{1+xy}}$$

$$=\frac{x^2y+y}{1+xy}\times\frac{1+xy}{x^2+1}$$

$$=\frac{x^2y+y}{x^2+1}$$

$$=y.$$ Ans.

3. What is a *Quadratic equation?* Name the different kinds, and state the difference between them.

$$\text{Solve } \frac{5x}{x+4} - \frac{3x-2}{2x-3} = 2.$$

A Quadratic Equation is one in which the square of the unknown quantity is found.

There are two kinds—*pure and adfected.*

A *pure* quadratic is one in which the square only is found, without the first power, as, $x^2+20=0$.

An *adfected* quadratic contains the first power, as well as the square, as, $x^2+2x+5=30$.

$$\frac{5x}{x+4} - \frac{3x-2}{2x-3} = 2$$

$$10x^2-15x-3x^2-10x+8=4x^2+10x-24$$
$$3x^2-35x=-32$$
$$36x^2-420x+(35)^2=-384+1225$$
$$6x-35=\pm 29$$
$$6x=6 \text{ or } 64$$
$$x=1 \text{ or } 10\tfrac{2}{3}. \quad \text{Ans.}$$

Mensuration.

A wheel turns round 4,400 times in a distance of 10 miles; what is its diameter?

10 miles = 17600 yds.

Circumference of wheel $= \frac{17600}{4400} = 4$ yds. $= 12$ ft.

3·14159 : 1 :: 12 ft. : 3·8197+ft. Ans.

Arithmetic.

FEMALES.

1. In a dictation lesson given to 35 scholars, 14 had no mistakes, 8 had 1, 6 had 2, 4 had 3, 2 had 5, and 1 had 7; find the average number of mistakes.

$14\times 0 = 0$ mistakes.
$8\times 1 = 8$,,
$6\times 2 = 12$,,
$4\times 3 = 12$,,
$2\times 5 = 10$,,
$1\times 7 = 7$,,
$35 = 49$ mistakes.
$1 = 1\frac{2}{5}$,, Ans.

2. Two men start in opposite directions to walk round a park, one at the rate of $3\frac{1}{2}$ miles an hour, the other at $4\frac{1}{4}$ miles an hour; they meet in 45 minutes. What is the distance round the park?

45 mins. $= \frac{3}{4}$ hr.

Distance walked by one $= \frac{3}{4}\times 3\frac{1}{2} = 2\frac{5}{8}$ miles.
,, ,, other $= \frac{3}{4}\times 4\frac{1}{4} = 3\frac{3}{16}$,,
,, round the park $= 2\frac{5}{8}+3\frac{3}{16}$
$= 5\frac{13}{16}$ miles. Ans.

3. If 20 men can do a piece of work in 14 weeks, working 6 days a week and 8 hours per day, in how many weeks will 18 men do it, working 5 days a week and 9 hours a day?

Men 18 : 20 : : 14 weeks : $16\frac{4}{9}$ weeks.
Days 5 : 6
Hours 9 : 8
$= 16\frac{4}{9}$ weeks. Ans.

4. I bought £2,500 Mexican Railway Stock at $70\frac{1}{2}$; on the stock rising to $78\frac{1}{2}$ I sold out. What was my gain, brokerage being paid in each case, and what would my yearly income be from the proceeds invested in the $3\frac{1}{2}$ per cents. at par?

Gain = (S. P. − C. P.) × No. of cents. of stock
$= (78\frac{1}{2}-\frac{1}{2})-(70\frac{1}{2}+\frac{1}{2})\times 25$
$= (78\frac{1}{2}-70\frac{1}{2})\times 25$
$=$ £206¼ gain. Ans.

Proceeds of sale $= 78\frac{1}{2}\times 25$
$= 1959\frac{3}{8}$
Annual income $= \frac{1959\frac{3}{8}\times 3\frac{1}{2}}{100}$
$=$ £68 11s. 6¾d. Ans.

Grammar.

MALES AND FEMALES.

1. Analyse the following, parsing the words in italics:—

None remember thee now thou'rt gone!
Or they could not choose *but weep*,
When they thought of thee, my gentle *one*,
In thy long and lonely sleep.
Fain would I murmur thy name, and tell
How fondly *together* we used *to dwell*—
But none remember thee
Save me. BARRY CORNWALL.

ANALYSIS.

Sentence.	Kind of Sentence.	Con. nec- tive.	Subject.	Predi- cate.	Object.	Exten- sion.
(*a*) None remember thee now	Princ. sent.		None	remem- ber	thee	now (time)
(*b*) thou art gone,	Adv. of time to *a*.	[that]	thou	art gone		
(*c*) Or they could not choose but weep	Princ. disj. co-ord. to *a*.	or	they	could not (neg.) choose	but [= except] weep (ind.)	
(*d*) When they thought of thee in thy long and lonely sleep.	Adv. (*time*) to *c*	when	they	thought	of thee, my gentle one, in thy long and lonely sleep [ind.]	
(*e*) Fain would I murmur thy name,	Princ. sent.		I	would murmur	thy name	fain manner)
(*f*) and tell	Princ. sent. co-ord. with *e*	and	[I]	[would] tell		
(*g*) how fondly together we used to dwell.	Noun sent. obj. to *f*.		we	used	to dwell together, how fondly [ind.]	
(*h*) But none remember thee save me.	Princ. sent. disj. co ord. with *e* and *f*.	but	none save me	remem- ber	thee	

None—numl. adj., qualg. 'persons' und.
or—disj. conj., joining the sents., 'None remember' and 'They could not choose.'
but—=*except*; prep., showing reln. between *anything* und. and *weep*.
Construction.—Choose *anything* except weeping or to weep.
(It might also be parsed as conj., or as an adverb if the constr. were *not but*=*only*.)
weep—irreg. intrans. verb, act., inf., pres., used as abs. noun =weeping, obj., gov. by *but*.
one—adj. used as noun, fem., sing., 2nd, nom. of address, or in app. with 'thee.'
fain—adv. of manner, qualifying *would murmur*.
how—adv. of deg., qualifying *fondly*.
together—adv. of manner, qualifying *to dwell*.
to dwell—irreg. intrans. verb, act., inf., pres., gov. by *used*.
save—prep., showing rel. between *none* and *one*.

2. To what language is English most closely related? Of what elements is it now composed?

English is a low German language, and is most closely related to Dutch, Frisian, and Flemish.

It is mainly composed of Saxon words, but it has in it a large mixture of Latin and French words, besides a few Greek, Celtic, Danish, Italian, Spanish, Portuguese, Arabic, Hindoo, Persian, Turkish, Hebrew, American, Russian, and other words.

3. Name some old English writers, and their works.

Cædmon - - - - -	*A practical paraphrase of Scripture History.*
Bœda (The Venerable Bede) -	*Ecclesiastical History.*
King Alfred - - - -	*Translations of Bede*:—part of the *Anglo-Saxon Chronicle.*
Layamon - - - -	*Brut.*

4. Into what periods may English literature be divided?

Old English - -	450 A.D. to 1100 A.D.
Early English - -	1100 ,, ,, 1250 ,,
Middle English -	1250 ,, ,, 1485 ,,
Modern English -	1485 ,, ,, 1885 ,,

Geography.

Answer two questions.

1. Draw a map of the Pacific Ocean.

2. Compare the river-systems of North America and Asia.

The mountains of America lie near the west coast, and there are thus no rivers of importance which flow in a westerly direction. A vast extent of territory lies east of the Rocky Mountains, unbroken by any elevations of magnitude. The rivers of America may thus be said to flow through an immense plain in a south-easterly direction, the largest being 4,000 miles in length.

In Asia, the highland is chiefly in the centre, and the most gentle slope is towards the Arctic Ocean. The southern slope is abrupt, and great masses of mountains occupy a great part of the remainder of the Continent. The rivers, therefore, are found in valleys, sometimes broad and extensive, but not so extensive as the prairies of America. Their courses are not so long, nor are they so well-suited for commerce as the rivers of America. Rivers in Asia drain every part of the great central table-land, and flow in all directions—north, south, east, and west.

3. Explain, as to a class, the phases of the moon.

The moon is a dark body, and can only reflect the light which is thrown on it. The sun can only shine on one-half the moon at once, and it depends entirely upon the positions of the sun, moon, and earth, with regard to each other, as to how much of that enlightened half we see on the earth.

If the sun and moon are on opposite sides of the earth, and the earth does not come between them, then the whole lighted surface of the moon is seen.

On the other hand, if they are both on the same side of the earth, then none of the lighted surface of the moon would be seen. These different appearances are called 'phases'; when the moon is seen at full it is called *full moon*, and when no moon at all is seen, then is the time of new moon. Between these two phases all the other phases come, gradually increasing or decreasing as the moon changes its position from the same to the opposite side of the earth from that occupied by the sun, or the reverse.

To make this explanation still more clear, use before the class the blackboard, the diagrams, and, if possible, the tellurium. If not available, a common globe held in the hand, with the sun or a lamp shining on it, can be made to serve the purpose.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

One hour allowed for working the needlework specimens.

Arithmetic.

MALES.

1. Which stock is best to invest in—the $3\frac{1}{2}$ per cents. at 93, or the 3 per cents. at 81?

The ratio of receipts in each stock is as

$$3\tfrac{1}{2} : \tfrac{3}{81}$$
$$93$$
$$\tfrac{1}{186} : \tfrac{3}{81}$$
$$507 : 558$$

The $3\frac{1}{2}$ per cents. are therefore the best investment.

2. Find the true discount on a bill for £275 6s. 8d. for 15 mos. at 4 per cent. per annum.

Int. on £100 for 15 mos. at 4 p.c. $= \frac{15}{12}$ of $4 = £5$.

∴ Discount on £275 6s. 8d. =

£ £ £ s. d. £ s. d.

105 : 5 :: 275 6 8 : 13 2 2½. Ans.

3. The distance from Newcastle to Carlisle is 60 miles, 15 miles being uphill, 20 downhill, and the rest level. If a bicyclist goes at the rate of 12 miles an hour on level ground, 15 miles downhill, and 5 miles uphill, what will be the difference in time between going to Carlisle and returning?

Time in going $= \frac{15}{5} = 3$ hours uphill
$\frac{35}{15} = 2\frac{5}{12}$,, on level
$\frac{20}{20} = 1$,, downhill
$= 6\frac{5}{12}$ hrs.

Time in returning $= \frac{15}{5} = 2\frac{5}{12}$ hours on level
$\frac{20}{5} = 4$,, uphill
$\frac{15}{15} = 1$ hour downhill
$= 7\frac{5}{12}$

Diff. $= 7\frac{5}{12} - 6\frac{5}{12} = \frac{2}{3}$ hr. or 40 min

4. Three workmen work together for half an hour at reaping. A could do the whole in 12 hours, B in 4, and C in 3 hours. C then left off. How long would A and B take to finish it?

Work done in 1 hr. $= \frac{1}{12} + \frac{1}{4} + \frac{1}{3} = \frac{8}{12}$
$\frac{1}{2}$,, $= \frac{4}{12}$ or $\frac{1}{3}$
Work still to do $= 1 - \frac{1}{3} = \frac{2}{3}$
A can do in 1 hr. $\frac{1}{12}$
B ,, ,, $\frac{1}{4}$
A + B ,, ,, $\frac{1}{12} + \frac{1}{4} = \frac{1}{3}$
Time for A and B to do $\frac{1}{3} = 1$ hr.
,, ,, $\frac{2}{3} = 2$ hrs. Ans.

History.

MALES AND FEMALES.

1. What events are connected with the following dates?—1745, 1759, 1760, 1801, 1832, 1846, 1851, 1854, 1867.

1745—Rebellion in Scotland; attempt of the Young Pretender to gain the throne.
1759—Conquest of Canada.
1760—Death of George II., and accession of George III.
1801—The Union of the English and Irish Parliaments.
1832—The passing of the First Reform Bill.
1846—The repeal of the Corn Laws—Famine in Ireland.
1851—The Great Exhibition.
1854—The Crimean War.
1867—The passing of the Second Reform Bill.

2. Explain briefly the Constitution of England.

The Government of England is a limited monarchy, and the three estates of the realm are the Sovereign, Lords, and Commons. The Sovereign acts upon the advice of a limited number of the members of the Privy Council, called the Cabinet Ministers. The sovereign alone has the power of making war or peace, or treaties, of exercising the prerogative of mercy in case of condemned criminals, and of conferring titles of nobility. The House of Lords is mostly hereditary. The House of Commons is elective, and consists of 658 members, from counties and boroughs of the United Kingdom. The House of Commons alone has the power of initiating money bills, but others may be introduced in either House. Before any proposition can become law, it must receive the sanction of the three estates of the realm.

3. What was the cause of the loss of the American Colonies in the reign of George III.?

In 1765 the Stamp Act was extended to the American Colonies, but the colonists objected to the imposition as being contrary to the spirit of the English constitution. In 1766 the Stamp Act was repealed, but duties were charged upon tea, glass, paper, etc., exported to the American colonies. Eventually all these were removed except the tax on tea. Riots took place, and at Boston, several shiploads of taxed tea were emptied into the harbour in 1773. Although strongly urged to yield by Chatham, Burke, and Fox, the Government refused, and a Declaration of Independence was made by the Colonists in 1774. Then followed a long and disastrous war. Battles were fought

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Query Column.

RULES.

1. Each correspondent is restricted to *one question*. We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.

2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.

3. ☞ When a pseudonym is adopted it should be written at the end of the query, and the real name and address on a separate piece of paper.

4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.

5. Replies will not be sent through the post.

6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—'*The Query Editor*,' *The Practical Teacher*, *Pilgrim Street, Ludgate Hill, London, E.C.*

Arithmetic.

1. CLIPPER.—Find at what time between 3 and 4 o'clock the minute-hand of a clock is 30 minutes before the hour-hand.

The minute-hand moves 12 times as fast as the hour-hand;
∴ The difference between the rates of the minute and hour-hands is 11 times the rate of the hour-hand;
The minute-hand must gain 45 min. on the hour-hand to be 30 minutes before it;

∴ Distance gone by hour-hand = 45 min. ÷ 11
= $4\frac{1}{11}$ min.;

∴ Time = 45 min. + $4\frac{1}{11}$ min. past 3
= $49\frac{1}{11}$ min. past 3.

2. PUZZLED.—(*a*) What income is derived from £1350 invested in the 6 per cents. at $111\frac{1}{4}$?

(*b*) What change in his income will the possessor of it make, if he sell out, and invest the proceeds in the $4\frac{1}{2}$ per cents. at $79\frac{7}{8}$, brokerage being charged in both transactions? (*Dalton.*)

(*a*) Income in 1st case = 6 p. c. on £1350
= £81. Ans.

(*b*) Stock in 2nd case = £1350 × $\frac{111}{80}$
= £$\frac{14985}{8}$;
Income ,, ,, = $4\frac{1}{2}$ p. c. on £$\frac{14985}{8}$
= £$\left(\frac{14985}{8} \times \frac{9}{200}\right)$
= £$\frac{2997}{320}$
= £84 5s. $9\frac{3}{8}$d.;

∴ Difference in incomes = (£84 5s. $9\frac{3}{8}$d. − £81) gain.
= £3 5s. $9\frac{3}{8}$d. gain. Ans.

3. ALIE SLOPER.—If silver be worth 5s. 6d. an oz. and pure gold be worth £4 5s. an oz., what would be the weight of a 15s.-piece, containing 92·5 per cent. pure gold and the rest silver?

(£4 5s. × $92\frac{1}{2}$) + (5s. 6d. × $7\frac{1}{2}$)
= (85s. × $92\frac{1}{2}$) + (5½s. × $7\frac{1}{2}$)
= 7862½s. + 41¼s.
= 7903¾s.;

s. s. oz.
∴ 7903¾ : 15 :: 100 : Weight of coin.
4 4
31615 60
6323 1200
20
24000 (3 dwts.
18969
5031
24
120744 (19 grs.
6323
57514
56907
607

= 3 dwts. $19\frac{607}{6323}$ grs. Ans.

4. PENDA.—Given the square of 10,129 is 102,596,641, find the square of 101,293 without going through the operation of squaring. (*Barnard Smith.*)

$(101,293)^2 = (101,290+3)^2$
$= (101,290)^2 + 2(101,290 \times 3) + (3)^2$
= 10,259,664,100 + 607,740 + 9
= 10,260,271,849. Ans.

5. D. McL. C., Lanark.—A sum of £3070 3s. 3d. has to be divided between A, B, and C, so that A may have $\frac{1}{3}$ of $\frac{1}{4}$ of B's share, and B $\frac{1}{4}$ of A's and C's together. Find their respective shares. (*Scholarship*, 1883.)

B's share = $\frac{1}{4}$ of A's + $\frac{1}{4}$ of C's
= $\frac{1}{4}$ of $\frac{1}{3}$ of $\frac{1}{4}$ of B's + $\frac{1}{4}$ of C's
= $\frac{1}{48}$ of B's + $\frac{1}{4}$ of C's,
B's share − $\frac{1}{48}$ of B's = $\frac{1}{4}$ of C's,
$\frac{47}{48}$ of B's share = $\frac{1}{4}$ of C's share,
∴ C's share = $\frac{47}{4}$ of $\frac{119}{27 \times 47}$ of B's share
= $\frac{119}{108}$ of B's share.
A's share + B's share + C's share
= £3070 3s. 3d.,
$\frac{1}{3}$ of B's share + B's share + $\frac{119}{108}$ of B's share
= £3070 3s. 3d.,
$(\frac{1}{3} + 1 + \frac{119}{108})$ of B's share = £3070 3s. 3d.,
$\frac{16+108+119}{108}$ of B's share = £3070 3s. 3d.,
$\frac{243}{108}$ of B's share = £3070 3s. 3d.,
$\frac{9}{4}$ of B's share = £3070 3s. 3d.,
∴ B's share = $\frac{4}{9}$ of £3070 3s. 3d.
= £12,280 13s. ÷ 9
= £1364 10s. 4d.

A's share = $\frac{1}{3}$ of £1364 10s. 4d.
= £5458 1s. 4d. ÷ 27
= £202 3s. $0\frac{4}{27}$d.

C's share = £3070 3s. 3d.
− (£1364 10s. 4d. + £202 3s. $0\frac{4}{27}$d.)
= £3070 3s. 3d. −
£1566 13s. $4\frac{4}{27}$d.
= £1503 9s. $10\frac{23}{27}$d.

6. MAGISTER.—A and B run 100 yards, and A wins by 2 yards. C and D run over the same course, and C wins by 6 yards. B and D also run over it, and B wins by 4 yards. If A and C run, who will win, and by how much? (*Cambridge Local*, 1880.)

B runs 98 yards while A runs 100 yards;
D ,, 94 ,, C ,, ,, ,,;
B ,, 100 ,, D ,, 96 ,,;
48

∴ While D runs 96 yards C runs $\frac{100 \times 94}{47}$ yds. = $\frac{4800}{47}$ yds.

50

While B runs 100 yards A runs $\frac{100 \times 98}{49}$ yds. = $\frac{5000}{49}$ yds.

$\therefore$ C runs $\frac{1}{47}\frac{9}{0}\frac{9}{0}$ yds. while A runs $\frac{1}{4}\frac{0}{0}\frac{0}{0}$ yds. ;

$\therefore$ C runs 100 yards while A runs $\left(\frac{\cancel{6}\cancel{0}\cancel{0}\cancel{0}}{49} \times \frac{47}{\cancel{4}\cancel{0}\cancel{0}\cancel{0}} \times 1\cancel{0}\cancel{0}\right)$ yds.;

$= \frac{1}{2}\frac{0}{3}\frac{0}{1}\frac{0}{2}$ yds.

$= 99\frac{3}{4}\frac{1}{3}\frac{2}{2}$ yds. ;

$\therefore$ C wins, and by $\frac{3}{1}\frac{1}{2}\frac{1}{2}$ yard. Ans.

7. MAGISTER.—A man mixes 5 per cent. of water with milk, which he sells to a milkman, who retails it after adding 5 per cent. of water to what he receives. What percentage of water is there in the milk retailed? (*Cambridge Local*, 1880.)

Percentage of water = 5 + 5 + 5% of 5

= 10 + $\frac{1}{2}$

= $10\frac{1}{2}$. Ans.

8. EVA.—Suppose the population of a country would increase annually by ·3 per cent. were it not for emigration, which annually carries off ·5 per cent. of the people, what will be the increase per cent. in the population after 5 years? What is the population of a country from which, at the above rate, 81,000 persons emigrate in 2 years?

Annual increase = $2\frac{1}{2}$ per cent. ;

100

2·5

102·5 (end of 1 year)

$2\frac{1}{2}\% = \frac{1}{40}$ = 2·5625

105·0625 (end of 2 years)

$\frac{1}{40}$ = 2·6265625

107·6890625 (end of 3 years)

$\frac{1}{40}$ = 2·6922265625

110·3812890625 (end of 4 years)

$\frac{1}{40}$ = 2·7595322265625

113·1408212890625 (end of 5 years)

$\therefore$ Increase after 5 years = 13·1408212890625%. Ans.

Emigration in 2 years = $\frac{1}{2}\% + \left(\frac{1}{2}\% \times \frac{102\frac{1}{2}}{100}\right)$

$= \frac{1}{2}\% + \left(\frac{1}{2} \times \frac{\cancel{2}\cancel{0}\cancel{5}}{\cancel{2}\cancel{0}\cancel{0}}\right)\%$ (41 / 40)

$= \frac{1}{2}\% + \frac{41}{80}\%$

$= \frac{40+41}{80}\%$

$= \frac{81}{80}\%$;

$\therefore$ Population = $81{,}000 \times \frac{80}{81} \times 100$

= 8,000,000. Ans.

9. G. C. M.—I bought 15 horses and 12 cows for £345. I sell the horses at a profit of 10 per cent., and the cows at a loss of $1\frac{1}{2}$ per cent., and receive in all £365 14s. What did I give for a horse and a cow? (*Evers.*)

(1) Cost of horses + cost of cows = £345,

(2) 10% of cost of horses − $1\frac{1}{2}$% of cost of cows = £365 14s. − £345,

$\frac{1}{10}$ cost of horses − $\frac{3}{200}$ cost of cows = £20 14s.

Cost of horses − $\frac{3}{20}$ cost of cows = £207,

(1) Cost of horses + cost of cows = £345,

$\therefore$ Cost of cows + $\frac{3}{20}$ cost of cows = £345 − £207

$\frac{23}{20}$ cost of cows = £138,

$\therefore$ Cost of cows = £138 × $\frac{20}{23}$

= £120.

Cost of horses = £345 − £120

= £225.

$\therefore$ Cost price of a horse = £225 ÷ 15

= £15 ;

" " cow = £120 ÷ 12

= £10.

10. OUSE.—Paid £30, including a duty of 5 per cent., for a Geneva watch. What did the duty amount to? (*Barnard Smith.*)

£ 1$\cancel{0}\cancel{0}$: £ 3$\cancel{0}$ :: £ 5 : Amount of duty.

7 2

5

10

£1 8s. 6$\frac{6}{7}$d. Ans.

11. 3RD-YEAR P. T.—A can do a piece of work in 12 hours, B in 4 hours, and C 3 hours. A, B, and C all work together for half-an-hour, when A leaves off. How long will it take B and C to finish the piece of work?

A can do the work in 12 hours,

B " " " 4 " ;

And C " " " 3 " ;

$\therefore$ A " in 1 hour $\frac{1}{12}$ of the work,

B " " $\frac{1}{4}$ " ;

And C " " $\frac{1}{3}$ " ;

$\therefore$ A, B, and C " $\frac{1}{12}+\frac{1}{4}+\frac{1}{3}$ of the work

$= \frac{1+3+4}{12}$ "

$= \frac{8}{12}$ "

$= \frac{2}{3}$ " ;

A, B, and C can do in $\frac{1}{2}$ hour = $\frac{1}{3}$ of the work ;

$\therefore$ Part remaining to be done = $\frac{2}{3}$ of the work ;

B and C can do in 1 hour $\frac{1}{4}+\frac{1}{3}$ of the work

$= \frac{3+4}{12}$ "

$= \frac{7}{12}$ " ;

$\therefore$ B and C will finish the work in $\left(\frac{2}{3} \div \frac{7}{12}\right)$ hours

$= \left(\frac{2}{\cancel{3}} \times \frac{\cancel{12}^{4}}{7}\right)$ hours

$= \frac{8}{7}$ hours

$= 1\frac{1}{7}$ hours. Ans.

Note.—Perhaps 80 per cent.

12. BREVIS.—A certain sum of money was divided among three persons, A, B, and C. Suppose that A's share was £264 12s., and C's £2 8s., and that A's share contained the value of B's, as often as B's share contained C's, what must the whole amount have been? (*Colenso.*)

$$\frac{\text{£264 12s.}}{\text{B's share}} = \frac{\text{B's share}}{\text{£2 8s.,}}$$

$$\frac{264\frac{1}{2}}{\text{B's share in pounds}} = \frac{\text{B's share in pounds}}{2\frac{2}{3}},$$

B's share in pounds × B's share in pounds $= 264\frac{1}{2} \times 2\frac{2}{3}$,

(B's share in pounds)$^2 = \frac{1}{2}\frac{3}{6}\frac{2}{6}\frac{2}{6} \times \frac{1}{6}\frac{2}{6}$

$= 1\frac{3}{3}\frac{8}{6}\frac{7}{6}\frac{6}{6}$,

B's share in pounds $= \sqrt{1\frac{3}{3}\frac{8}{6}\frac{7}{6}\frac{6}{6}}$

$= 1\frac{1}{6}\frac{9}{6}$

$= 25\frac{1}{6}$;

$\therefore$ B's share = £25 4s. ;

$\therefore$ Sum = £264 12s. + £25 4s. + £2 8s.

= £292 4s. Ans.

Algebra.

1. UNITY.—Solve :—

$$\frac{5x-4}{x+2} = 10 - \frac{8x-5}{5}. \quad \text{(Mansford.)}$$

$$\frac{5x-4}{x+2} = 10 - \frac{8x-5}{5}$$

$$= 10 - \left(\frac{8x}{5} - 1\right)$$

$$= 10 - \frac{8x}{5} + 1$$

$$= 11 - \frac{8x}{5}$$

$$5(5x-4) = 55(x+2) - 8x(x+2)$$

$$25x - 20 = 55x + 110 - 8x^2 - 16x$$

$$8x^2 + 16x + 25x - 55x = 110 + 20$$

$$8x^2 - 14x = 130$$

$$x^2 - \frac{7x}{4} = \frac{6}{4}\frac{5}{4}$$

$$x^2 - \frac{7x}{4} + \left(\frac{7}{8}\right)^2 = \frac{6}{4}\frac{5}{4} + \frac{4}{6}\frac{9}{4}$$

$$= \frac{1040+49}{64}$$

$$= \frac{1}{6}\frac{0}{4}\frac{8}{4}\frac{9}{4}$$

$$x - \frac{7}{8} = \pm\frac{3}{8}\frac{9}{4}$$

$$x = \pm\frac{3}{8}\frac{9}{4} + \frac{7}{8}$$

$\therefore$ $x = 5$, or $-3\frac{1}{4}$.

2. D. E. K.—Find the value of:—

$$\frac{a^2}{(a-b)(a-c)}+\frac{b^2}{(b-a)(b-c)}+\frac{c^2}{(c-a)(c-b)}.$$

(*Todhunter.*)

$$\frac{a^2}{(a-b)(a-c)}+\frac{b^2}{(b-a)(b-c)}+\frac{c^2}{(c-a)(c-b)}$$
$$=\frac{a^2}{(a-b)(a-c)}+\frac{b^2}{-(a-b)(b-c)}+\frac{c^2}{-(a-c)\times-(b-c)}$$
$$=\frac{a^2}{(a-b)(a-c)}-\frac{b^2}{(a-b)(b-c)}+\frac{c^2}{(a-c)(b-c)}$$
$$=\frac{a^2(b-c)-b^2(a-c)+c^2(a-b)}{(a-b)(a-c)(b-c)}$$
$$=\frac{a^2b-a^2c-ab^2+b^2c+ac^2-bc^2}{a^2b-ab^2-a^2c+ac^2+b^2c-bc^2}$$
$$=\underline{1.}\quad \text{Ans.}$$

3. 4TH YEAR P. T.—There are two numbers; if one-fifth of the second be taken from it and added to the first, they will be equal; but if one-third of the first be taken from it and added to the second, then the second will be three times as great as the first. Find the original numbers. (*Moffatt's* 'Pupil Teachers' Course.')

Let x and y = the two numbers;

Then, (1) $x+\frac{y}{5}=\frac{4y}{5}$

(2) $\frac{2x}{3}\times 3=y+\frac{x}{3}$

(1) $x=\frac{4y}{5}-\frac{y}{5}$

(2) $2x-\frac{x}{3}=y$

(1) $x=\frac{3y}{5}$

(2) $\frac{5x}{3}=y$

(1) $5x=3y$

(2) $5x=3y$

∴ Any multiples of 3 and 5 satisfy the conditions.

∴ Nos. = 3 and 5, or 6 and 10, or 9 and 15, etc.

Note.—The question is not complete. A similar one from the same work was solved in our issue for June, 1884.

4. J. WM. ALLEN.—Twenty men are employed on a certain work, only eighteen of them, however, working at one time, while the other two are resting. A change is made in the group at work every hour. How many hours will have elapsed before every possible group has been at work together for one hour? (*Cassell's* 'Saturday Journal.')

$$\text{No. of combinations}=\frac{\not{20}.19}{1.\not{2}}=190;$$

∴ Time = 190 hours. Ans.

5. NOBODY.—A person having invested £2,000 in the 3 per cents., and £3,300 in the 3½ per cents., derives therefrom an income of £211 5s. If his investment had been £550 more in the former and £550 less in the latter, his income would have been just 2s. 6d. more. What were the respective prices of stock? (*Colenso.*)

Let x and y = Prices of stocks in pounds;

Then, (1) $\left(\frac{2000}{x}\times 3\right)+\left(\frac{3300}{y}\times 3\frac{1}{2}\right)=211\frac{1}{4}$

(2) $\left(\frac{550}{x}\times 3\right)-\left(\frac{550}{y}\times 3\frac{1}{2}\right)=\frac{1}{8}$

(1) $\frac{6000}{x}+\frac{23100}{2y}=\frac{845}{4}$

(2) $\frac{1650}{x}-\frac{3850}{2y}=\frac{1}{8}$

(1) $\frac{6000}{x}+\frac{23100}{2y}=\frac{845}{4}$

(2) $\frac{9900}{x}-\frac{23100}{2y}=\frac{3}{4}$

$$\frac{15900}{x}=\frac{849}{4}$$
$$=212$$

∴ $x=\frac{15900}{212}$

$=\underline{75.}$

(2) $\frac{1650}{x}-\frac{3850}{2y}=\frac{1}{8}$

$\frac{1650}{75}-\frac{3850}{2y}=\frac{1}{8}$

$22-\frac{1}{8}=\frac{3850}{2y}$

$21\frac{7}{8}=\frac{3850}{2y}$

$\frac{175}{8}=\frac{3850}{2y}$

22

∴ $y=\frac{\not{3850}}{\not{175}}\times\frac{\not{8}^{4}}{1}$

$=\underline{88.}$

∴ Prices of stocks = 75 and 88.

6. J. BURROWS.—Simplify:—

$$(x+3)^3-3(x+2)^3+3(x+1)^3-x^3.$$
$$(x+3)^3-3(x+2)^3+3(x+1)^3-x^3$$
$$=x^3+9x^2+27x+27-3(x+6x^2+12x+8)$$
$$+3(x^3+3x^2+3x+1)-x^3$$
$$=9x^3+27x+27-3x^3-18x^2-36x-24+3x^3+9x^2+9$$
$$x+3$$
$$=\underline{6.}\quad \text{Ans.}$$

7. CYCLOPS.—Solve:—

$$\left.\begin{aligned}7yz&=10(y+z)\\3xz&=4(z+x)\\9xy&=20(x+y)\end{aligned}\right\}$$

Todhunter's 'Algebra for Beginners.'

(1) $7yz=10(y+z)$

(2) $3xz=4(x+z)$

(3) $9xy=20(x+y)$

(2) $3xz=4(x+z)$

$=4x+4z$

$3xz-4z=4x$

$(3x-4)z=4x$

∴ $z=\underline{\frac{4x}{3x-4}}$

(3) $9xy=20(x+y)$

$=20x+20y$

$9xy-20y=20x$

$(9x-20)y=20x$

∴ $y=\underline{\frac{20x}{9x-20}}$

(1) $7yz=10(y+z)$

$$7\times\frac{20x}{9x-20}\times\frac{4x}{3x-4}=10\left(\frac{20x}{9x-20}+\frac{4x}{3x-4}\right)$$
$$\frac{560x^2}{(9x-20)(3x-4)}=10x\left\{\frac{20(3x-4)+4(9x-20)}{(9x-20)(3x-4)}\right\}$$
$$56x=60x-80+36x-80$$
$$56x-96x=-160$$
$$-40x=-160$$
$$\therefore\ \underline{x=4.}$$

$$y=\frac{20x}{9x-20}=\frac{80}{36-20}=\frac{80}{16}=5;$$

$$z=\frac{4x}{3x-4}=\frac{16}{12-4}=\frac{16}{8}=2.$$

8. CYCLOPS.—Resolve into factors:—

$x^2-y^2-3x-y+2$. (*Harrow School Entrance Scholarship*, 1884.)

First Method.

$$x^2-y^2-3x-y+2$$
$$=x^2-3x+2-y-y^2$$
$$=(x^2-3x+2)-2y+y+xy-xy-y^2$$
$$=(x^2-3x+2)+xy-2y-xy+y-y^2$$
$$=(x-2)(x-1)+y(x-2)-y(x-1)-y^2$$
$$=(x-2)(x-1)+y\{(x-2)(x-1)\}-y^2$$
$$=\{(x-2)-y\}\{(x-1)+y\}$$
$$=(x-2-y)(x-1+y)$$
$$=\underline{(x-y-2)(x+y-1).}\quad \text{Ans.}$$

Second Method.

$$\begin{aligned}&x^2-y^2-3x-y+2\\&=(x^2-y^2)-2x-2y-x+y+2\\&=(x^2-y^2)-2(x+y)-(x-y)+2\\&=(x+y)(x-y)-\{2(x+y)+(x-y)\}+2\\&=\{(x+y)-1\}\{(x-y)-2\}\\&=(x+y-1)(x-y-2).\end{aligned}$$ Ans.

Note.—The second method is simpler.

9. STUDENT.—Solve:—

$$\left.\begin{aligned}x^2+y^2-xy(x+y+2)+x^2y^2&=31\\x+y+xy&=11\end{aligned}\right\}$$

(*Certificate, Second Year*, 1884.)

$$\left.\begin{aligned}(1)\quad x^2+y^2-xy(x+y+2)+x^2y^2&=31\\(2)\quad x+y+xy&=11\end{aligned}\right\}$$

Substituting from (2):

$$\begin{aligned}(1)\quad &x^2+y^2-xy(x+y+xy)-2xy+2x^2y^2=31\\&x^2+y^2-11xy-2xy+2x^2y^2=31\\&x^2+y^2=13xy-2x^2y^2+31.\end{aligned}$$

$$\begin{aligned}(2)\quad &x+y=11-xy\\&(x+y)^2=(11-xy)^2\\&x^2+2xy+y^2=121-22xy+x^2y^2\\&x^2+y^2=121-24xy+x^2y^2.\end{aligned}$$

$$\begin{aligned}&\therefore\ 121-24xy+x^2y^2=13xy-2x^2y^2+31\\&x^2y^2+2x^2y^2-24xy-13xy=31-121\\&3x^2y^2-37xy=-90\\&x^2y^2-\frac{37xy}{3}=-30\\&x^2y^2-\frac{37xy}{3}+(\tfrac{37}{6})^2=\tfrac{1369}{36}-30\\&=\frac{1369-1080}{36}\\&=\tfrac{289}{36}.\\&xy-\tfrac{37}{6}=\pm\tfrac{17}{6}\\&xy=\pm\tfrac{17}{6}+\tfrac{37}{6}\\&\therefore\ xy=9,\text{ or }\tfrac{10}{3}.\end{aligned}$$

$$\begin{aligned}(2)\quad x+y&=11-xy\\&=11-9\\&=2\end{aligned}$$

$$\left.\begin{aligned}x^2+2xy+y^2&=4\\4xy&=36\end{aligned}\right\}$$

$$\begin{aligned}x^2-2xy+y^2&=-32\\(x-y)^2&=-32.\end{aligned}$$

Now as the square of any quantity is positive, the value $xy=9$ is inapplicable.

$$\begin{aligned}(2)\quad x+y&=11-\tfrac{10}{3}\\&=\tfrac{23}{3}\end{aligned}$$

$$\left.\begin{aligned}x^2+2xy+y^2&=\tfrac{529}{9}\\4xy&=\tfrac{40}{3}\end{aligned}\right\}$$

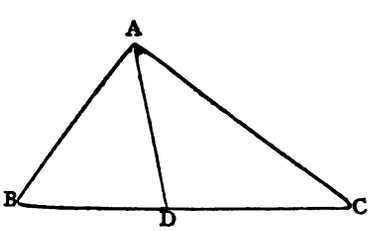
$$\begin{aligned}x^2-2xy+y^2&=\tfrac{409}{9}\\(x-y)^2&=\tfrac{409}{9}\\\therefore\ x-y&=\frac{\pm\sqrt{409}}{3}\\x+y&=\tfrac{23}{3}\end{aligned}$$

$$\begin{aligned}\therefore\ 2x&=\frac{23\pm\sqrt{409}}{3},\\2y&=\frac{23\mp\sqrt{409}}{3};\end{aligned}$$

$\therefore\ x=\frac{1}{6}(23\pm\sqrt{409})$, and $y=\frac{1}{6}(23\mp\sqrt{409})$. Ans.

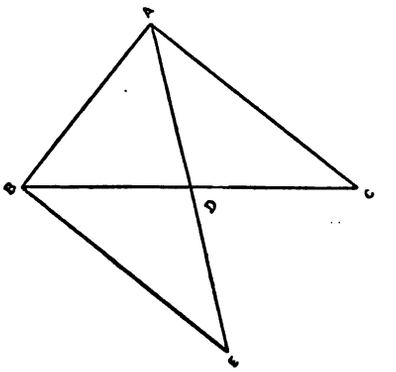
Geometry.

1. J. YOUNG.—ABC is a triangle, and the angle A is bisected by a straight line which meets BC at D; show that BA is greater than BD, and CA greater than CD. (*Todhunter.*)



Proof.—$\angle$ BDA is greater than $\angle$ CAD; (I. 16.)
$\angle$ CAD = $\angle$ BAD; (Hyp.)
$\therefore$ $\angle$ BDA is greater than $\angle$ BAD;
Wherefore side BA is greater than side BD (I. 19.)
Similarly it can be proved that CA is greater than CD.
Q. E. D.

2. W. THOMSON.—The two sides of a triangle are together greater than twice the straight line drawn from the vertex to the middle point of the base. (*Todhunter.*)

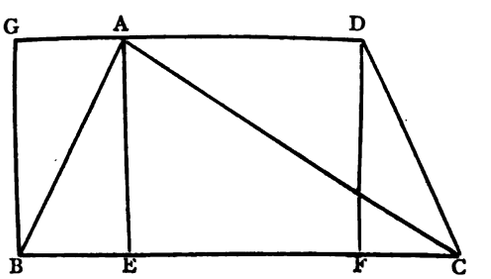


Let ABC be a triangle, and D the middle point of the base BC. Join AD. Then AB and AC together shall be greater than twice AD.

Produce AD to E, so that DE s equal to AD. Join BE.

Proof.—In the two triangles ADC, EDB, the two sides AD, DC = the two sides ED, DB, each to each,
and $\angle$ ADC = $\angle$ EDB; (I. 15.)
$\therefore$ base AC = base BE. (I. 4.)
The two sides AB, BE are greater than AE; (I. 20).
$\therefore$ The two sides AB, AC are greater than AE, that is, greater than twice AD.
Q. E. D.

3. G. F. A. BOLDMERE.—If the two sides of a trapezium be parallel, show that its area is equal to that of a rectangle contained by its altitude and half the sum of its parallel sides. (*Christ's College, Cambridge*, 1851.)



Let ABCD be a trapezium, having the sides AD, BC parallel. Then the area of the trapezium ABCD shall be equal to the area of the rectangle contained by half the sum of AD, BC, and the altitude of the trapezium.

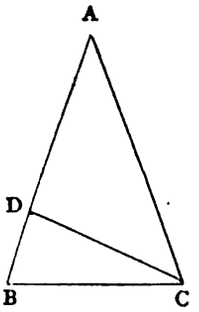
Draw AE, DF perpendicular to BC, and BG perpendicular to DA produced.

Proof.—$\triangle$ ABC = $\frac{1}{2}$ rectangle GBFD (I. 41), that is, $\frac{1}{2}$ rectangle contained by BC.AE;
$\triangle$ ACD = $\frac{1}{2}$ rectangle AE.FD, that is, $\frac{1}{2}$ rectangle contained by AD.AE;
$\therefore$ $\triangle$ ABC + $\triangle$ ACD = $\frac{1}{2}$ rectangle BC.AE + $\frac{1}{2}$ rectangle AD.AE;
$\therefore$ Area of trapezium ABCD = $\frac{1}{2}$ area of rectangle contained by (BC + AD).AE
= Area of rectangle contained by $\frac{1}{2}$(AD + BC).AE.
Q. E. D.

4. WILL O' TH' WISP.—From one of the equal angles of an isosceles triangle, a perpendicular is drawn to the opposite side.

Show that the square on the base is equal to twice the rectangle contained by that side, and the part of it between the perpendicular and the base. (*Deduction to Euclid*, II. 4.)

Let ABC be an isosceles triangle, and let CD be drawn perpendicular to AB.



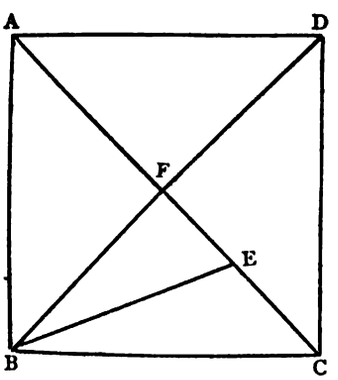
Then, BC^2 shall equal 2 AB.BD.

Proof.—$AB^2 = AD^2 + BD^2 + 2$ AD.BD (II. 4).
$\therefore$ $AC^2 = AD^2 + BD^2 + 2$ AD.BD;
But, $AC^2 = CD^2 + AD^2$; (I. 47.)
$\therefore$ $CD^2 + AD^2 = AD^2 + BD^2 + 2$ AD.BD;
Wherefore, $CD^2 = BD^2 + 2$ AD.BD; (Ax. 3.)
And $CD^2 = BC^2 - BD^2$; (I. 47.)
$\therefore$ $BC^2 - BD^2 = BD^2 + 2$ AD.BD;
Wherefore, $BC^2 = 2\,BD^2 + 2$ AD.BD (Ax. 2.)
$= 2\,(BD^2 + AD.BD)$
$= 2$ AB.BD. (II. 3.)

Q. E. D.

Note.—It can be proved directly from II. 13, Case 1.

5. NATAL.—ABCD is a square, and AC a diagonal. In AC a point E is taken. Show that the triangle, whose sides are equal to AE, EC, and the diagonal of square described on BE, will contain a right angle. (*Deduction to* II. 9.)



Let the diagonals AC, BD intersect in F.

Proof.—$AE^2 + EC^2 = 2AF^2 + 2EF^2$ (II. 9.)
$= 2BF^2 + 2EF^2$
$= 2BE^2$ (I. 47.)
= Square of the diagonal of a square described on BE;

$\therefore$ The triangle described with sides equal to AE, EC, and the diagonal of a square on BE, is right-angled. (I. 48.)

Q. E. D.

General.

1. P. T.—The solution of your query appeared in our *last* issue.

2. M. R. S.—Your query was solved in our issue for June, 1884. See No. 5 of Algebraical Queries.

3. DARIUS.—You will find the solution of your query in our issue for March, 1884.

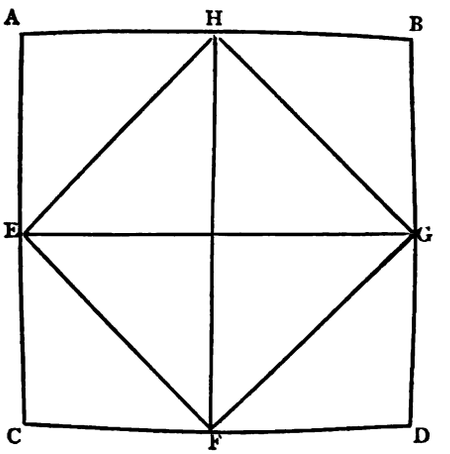
4. FRANK.—The solution of your query appeared in our issue for November, 1882. See model answers to Scholarship Questions.

5. BOUNCING BOY.—If you will kindly comply with Rules 2 and 3 of the query column, we shall have pleasure in replying to your query.

6. GWILYM TIMOTHY JONES.—We do not reply to anonymous queries.

7. DON CÆSAR.—You will find the solution of your first query in our issue for April, 1882, and the solution of your second in our issue for December, 1884.

8. POM-POM.—To cut away half a square, and leave a square as high and as wide as it was before. EFGH is half the size of



ABCD; it is also a square, and EG is equal to AB, and FH to AC.

9. MEMORY AND SUCCESS, AND I. B. S. O. S.—We cannot possibly tell you what you want to know. You must use your judgment. You seem to think few people can remember anything. This is not true. Very many would like to learn the art of forgetting. In the absence of revelation you should be guided by science. All that is known about mental development you will find in *Prof. Sully's* 'Outlines of Psychology' (Longman and Co.

10. CONSTANT READER.—Read the syllabus to see which essays, and how many. Get *Abbott's* edition as well. You have a play of Shakespeare to prepare; use the Clarendon Press Edition, together with *Abbott's* 'Shakespearian Grammar.' Your list of books seems sufficient. Mind your spelling, and where you put capitals and apostrophes.

11. DON'T KNOW.—Your writing is very poor indeed. Get good copy-books and practise daily.

12. NOV. NAV.—The subject is too extensive to be dealt with in the query column. Consult some qualified person, and ask for detailed instructions.

13. E. W. SYLVESTER.—Small hand, 75; large hand, 80.

14. EXCELSIOR.—Yes, and more will do so. Enter if you can. Many Boards only recognise trained teachers.

15. SCIENTIST.—(1) It means that teachers receive marks for one or two sciences if they hold certificates for them, but not for more than two. (2) It is hard to say. *Fownes'* 'Manual' is exceedingly good: last edition 1883.

16. FERGUS STEWART.—Elliott and Co., Strand; Becker and Co., Maiden Lane, Strand.

17. W. P.—Both the sentences are right. 'Avus magistro agros dat.'

18. JOHN WILLIAMS.—*Mackay's* 'Geography,' and *Hewett's* 'Colonies.' *Hume's* 'History,' Part III. 'The Nineteenth Century,' by *Nelson*. *Dr. Smith's* 'English Grammar,' *Dr. Abbott's* 'Shakespearian Grammar,' and the Clarendon Press Edition of the 'Tempest.'

19. O. M.—You have the right edition, and seem to have a good method. You do not need to know the text so familiarly as if you were reading a book of Milton. The best thing for you to do would be to refer to the last three calendars, and see the sort of questions set upon similar books.

20. LEGON.—It is difficult to say which is the best. *Dr. Smith's* 'French Principia' is very good. *Farnacht's* course is shorter; but there are many excellent books. You cannot get the pronunciation from books alone. You may consult the lessons passing through the *Scholar* with advantage.

21. ZANONI.—Are you sure the question was put as you say? We will then give you an answer, and some advice into the bargain.

22. W. T. SOUTHERN.—Your hand-writing in no case reaches fair; a Fourth Standard boy should do better.

23. IL PENSEROSO.—(1) Cannot say: most likely all equal. (2) You cannot possibly get to know the exact number of marks. One would think honours worth most. (3) A second stage in mathematics would not count for the Second Year's Papers.

24. SUBSCRIBER.—(1) 75; (2) 65.

Write to the Registrar of the London University for a Syllabus of the Matriculation Examination, and also one for degrees in science. You will find all you want in them. Always read your letters before sending them.

25. B. SCRIBE.—All equal in value. Hold your pen properly. The lower curves are heavy, and the letters too far apart.

26. J. E. R.—Writing too upright; capitals badly shaped; connections abrupt, and curves far too flat. Take our advice, and don't try to get a science certificate by reading *Huxley's* 'Lessons in Physiology' (not Phisiology, as you write it). You cannot learn Physiology by reading a book. Persons have been known to get certificates by so doing, but they lose more than they gain. Give the time to French and drawing.

27. ELLEN FORD.—65. Shape of letters very fair. Dont paint the large-hand. Small-hand is good. Keep to the round style of writing.

28. J. EDWARDS.—By Boyle's law, the volume occupied by a gas varies inversely as the pressure. The law can be verified: see PRACTICAL TEACHER, Vol. IV., page 217. As the cross section of the cylinder will continue the same, the length of the column will vary inversely as the pressure. Let x equal the length of the cylinder, then

$$20x = 30(x-2)$$
$$10x = 60; \quad \text{whence } x = 6.$$

29. CONSTANT SUBSCRIBER.—For the 'Tempest' use *Clarendon Press* edition. *Hume's* 'History' is suitable; it is published in parts. You want Part III. The syllabus of school management is now much extended. You need to study some elementary logic, say *Jevon's* 'Primer,' and also some mental science, which can only be got at present from *Prof. Sully's* 'Psychology' (Longman and Co.) Use *Curwen's* 'Manuals for Music.' There is no arithmetic in the Second Year's Papers.

30. UN AMI FIDELE.—The questions set last year are published, and can be had for 6d. through any bookseller. You ought to succeed. Use *Findlater's* 'Physiography,' and especially *Huxley's*.

31. PUZZLED.—Would you kindly repeat your query, as you have evidently copied it incorrectly?

32. E. BONARIA.—If $A+B+C=90°$, prove that

$$\text{Cot } A+\text{cot } B+\text{cot } C=\text{cot } A \text{ cot } B \text{ cot } C.$$

(*Civil Service*, 1879.)

$$\text{Cos}(A+B+C)=\text{Cos } 90°=0;$$
$$\text{And Cos}(A+B+C)=\text{Cos}\{A+(B+C)\}$$
$$=\text{Cos } A \text{ cos}(B+C)-\text{sin } A \text{ sin}(B+C)$$
$$=\text{Cos } A(\text{cos } B \text{ cos } C-\text{sin } B \text{ sin } C)$$
$$-\text{sin } A(\text{sin } B \text{ cos } C+\text{sin } C \text{ cos } B)$$
$$=\text{Cos } A \text{ cos } B \text{ cos } C-\text{sin } B \text{ sin } C \text{ cos } A$$
$$-\text{sin } A \text{ sin } B \text{ cos } C-\text{sin } A \text{ sin } C \text{ cos } B;$$

$$\therefore \text{Cos } A \text{ cos } B \text{ cos } C-\text{sin } B \text{ sin } C \text{ cos } A$$
$$-\text{sin } A \text{ sin } B \text{ cos } C-\text{sin } A \text{ sin } C \text{ cos } B=0,$$

Wherefore,

$$\text{Cos } A \text{ cos } B \text{ cos } C=\text{Sin } B \text{ sin } C \text{ cos } A$$
$$+\text{sin } A \text{ sin } B \text{ cos } C+\text{sin } A \text{ sin } C \text{ cos } B,$$

(Dividing by sin A sin B sin C),

$$\frac{\text{CosA}}{\text{SinA}}\cdot\frac{\text{CosB}}{\text{SinB}}\cdot\frac{\text{CosC}}{\text{SinC}}=\frac{\text{CosA}}{\text{SinA}}+\frac{\text{CosC}}{\text{SinC}}+\frac{\cos B}{\sin B},$$

$$\text{Cot } A \text{ cot } B \text{ cot } C=\text{Cot } A+\text{cot } C+\text{cot } B;$$

$$\therefore \text{Cot } A+\text{cot } B+\text{cot } C=\text{Cot } A \text{ cot } B \text{ cot } C.$$

33. TUTUS DUM RECTUS.—The sentence is elliptical and exclamatory. The ellipsis may be supplied as below.

Sentence.	Kind of Sent.	Subj.	Predicate.	Object.	Extension.
(*a*) Now by the lips of those fair gentlemen of France, charge for the golden lilies—upon them with the lance.	Princ. Sent. contracted in subj. and pred.	[I]	[bid]	You fair gentlemen of France (dir. object) [to] charge for the golden lilies—[to set] upon them with the lance.	Now (time) by the lips of those (reason)
(*b*) Ye love.	Adj. to 'those' in (*a*)	ye	love		

34. STORM.—Turn to Todhunter's "Mechanics for Beginners," p. 272, and use the formula there established. Any good book on dynamics embraces what you want.

35. GENTIL.—We did not ask you to repeat the query, but to state where your difficulty lay, so that we could assist you. Read the book we named, and study it. You will be rewarded.

Matriculation Hints.

BY HENRY A. REATCHLOUS, M.A. (LOND.), B.Sc.,
Westminster Training College.

THE ENGLISH LANGUAGE, ENGLISH HISTORY, AND MODERN GEOGRAPHY.—Under the head of English the syllabus specifies orthography, writing from dictation, and the grammatical structure of the language. This would of itself be somewhat vague. The candidate should look at the questions set at the last three or four examinations. He will then get a pretty clear notion of what is expected. As regards the dictation exercise, it need only be said that it is generally a piece from some standard author, and fills a page of the answer-book. It is read three times; once to get the drift of it, a second time to write it, and a third time to correct and punctuate it. It is usually read rather rapidly. It would therefore be well for the candidate to ask a friend to read a few pieces to him by way of practice, or he may become confused on the examination day.

For the rest of the paper considerable preparation is necessary. It is not easy to name any one book in preference to the rest. There are many good manuals in use. Possibly our readers have already a fair knowledge of grammar, and can parse and analyse with ease. All they need in addition would be found in 'The Elementary Lessons in Historical English Grammar,' by Morris (Macmillan, 2s. 6d.). Dr. Smith's 'School Manual of English Grammar' (Murray, 3s. 6d.) contains in itself probably all that would be required. It is a good book. The student would do well to make it a sort of text-book, and consult some other books on special points. If he intends proceeding to a degree in arts, he may very well do more English than will be barely enough for the matriculation. Dr. Abbott's 'How to Parse,' and the introduction to his 'Shakespearean Grammar,' are well worth consulting. Books like Trench's 'English Past and Present,' and his 'Study of Words,' and Dean Alford's 'Queen's English,' are light and easy reading, and at the same time very instructive.

In regard to the English history, it will also be advisable to consult the questions set within the last two years. It will be most likely admitted that the questions are such as might be expected. To answer

them satisfactorily one must have read a good history and become fairly well acquainted with it. The 'Student's Hume' (price 7s. 6d.) would, we think, meet all requirements. If some parts of Green's 'Short History of the English People' (price 8s. 6d.) could be read too, so much the better. It must be remembered that the history and geography bring as many marks as Greek or French. The examiners are right therefore in expecting that a fair amount of time and attention should be bestowed upon this part of the work. The answers should be clearly thought out and well expressed. Above all, gross blunders and guesses should be avoided. They may often just turn the scale and secure a candidate's rejection.

Modern geography is included in the paper on history. Usually four questions are set, two of which must be attempted. Of course the words modern geography may stand for a good deal. A student, however, who is pressed for time may content himself with preparing the geography of the British Isles and the Colonies. He should also pay attention to places of interest at the time of the examination. Mackay's 'Geography' and Hewett's 'Colonies' will be quite enough, if used in connection with a good recent atlas. A neat map adds considerably to the value of an answer.

In conclusion, a few words on the manner of answering questions may not be out of place. There must be a very general impression abroad that penmanship and neatness count for little. In no other way could the badness of the writing and want of style be accounted for. It is pretty certain that in future candidates will be expected to leave their answers in a more readable form. Indeed, they were cautioned at the last examination by the registrar against sending in books that required more time to decipher than the examiners could afford. The writing from beginning to end should be perfectly and easily legible. One should be able to see at a glance where one question ends and another begins. The number of each question should be attached to the answer to it. In the case of arithmetic and algebra the result may be underlined. The steps by which it was obtained should be easy to trace.

The use of instruments is allowed. There is, therefore, no excuse for slovenly figures in geometry. The letters in the diagrams and in all references to them should be printed, not written. All recognised contractions can be employed. It is quite possible, therefore, to arrange the steps in the reasoning so that each important statement occupies one line. In the papers on natural philosophy diagrams should be a special feature. They should be neatly drawn, and in such a way as to show that the candidate knows what is essential in a piece of apparatus, and knows how to set it up so that it will work. Even where a diagram is not asked for it may be desirable to draw one. It helps the candidate to realise the conditions of the problem he has to solve. Diagrams are equally necessary in answering the chemistry paper. A few well-drawn figures will do more to make it clear to the examiner that the candidate understands the subject than pages of directions and descriptions. Finally, the answers should be looked over, even if hastily, before they are left. Mistakes would often be detected and marks saved. Candidates often forget to put their numbers upon their books; occasionally they put a wrong number upon them. They should not be surprised, then, to learn that they do other foolish things, which a rapid revision of their work would enable them to rectify.

Style, some may think, means very much more than has yet been said. And no doubt it does. The selection of the matter, the method of arranging it, the expression of it, far more than the mere penmanship, enter into the style of answering. We have simply insisted on the part which should never be absent, and which lies within the reach of all. But while it is within the reach of all it is not reached by one in five, perhaps much less. Allowance must be made for nervousness and excitement; when that has been done there remains much room for improvement, and if the candidates realised how greatly it would add to their chance of success, they would not be slow to give attention to it.

ANSWERS TO ARITHMETICAL QUESTIONS IN 'THE SCHOLAR' FOR FEBRUARY, 1885.

STANDARD III.

A. 1. 189902+1969.
2. 58169+3779.
3. 42971+1132.

B. 1. 62137+1781.
2. 110148+1721.
3. 26040+1670.

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C. 1. 11 mos.
2. $\frac{3}{10}$.

3. ·0015.

D. 1. £453 12s.
2. ⅞⅞⅞.
3. 10s. 11⅜d. $\frac{1}{15}$q.

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3. £800.

C. 1. 5$\frac{5}{15}$.
2. £7 5s. 11$\frac{1}{25}$d.

3. £3097 10s.

D. 1. 4 yrs.
2. 4s. 8½d.
3. £120 15s.

E. 1. £2020; £1616.
2. 9·28.
3. £773 6s.

Publications Reviewed.

Patent Mechanical Globe. Designed by W. Rice, F.R.G.S. London and Liverpool: George Philip and Son.

The *raison d'etre* of this ingeniously-devised apparatus is to supply teachers with a handy means of illustrating those complex motions of the earth, with respect to the sun and to the plane of its own orbit, which give rise to the alternation and varying lengths of day and night, the succession of the seasons, and the various other concomitant phenomena. Exigencies of space forbid us from entering into a detailed description of Mr. Rice's invention, and the method of using it. That method is described in the explanatory pamphlet supplied with the apparatus, and it must suffice for us to say that, if the reader can imagine a square blackboard, with a large circular opening in it, mounted upright on a stand, and in that opening a brass ring rotating on vertical pivots, with a globe mounted in that ring so as to revolve on an axis 23½ degrees out of the perpendicular, he will be able to form a fair idea of its appearance. We may add that the position of the sun is indicated by a brass ball fixed on a semi-circular brass wire in front of the instrument, and that, of course, that half of the rotating globe which is on the same side of the blackboard as the brass ball is supposed to be enjoying day-time, and that on the opposite side night. We must cogratulate the inventor on having given to the teaching profession an instrument which, if properly used, can hardly fail to convey clearer ideas of the diurnal and annual motions of our globe, and the effects thereof, than the most elaborate of diagrams.

The 'Selenotrope.' Designed by W. Rice, F.R.G.S. London and Liverpool: George Philip and Son.

This apparatus, devised by the same inventor as the Mechanical Globe above referred to, is, as the name implies, a means of illustrating the phases of our satellite, the moon. It affords so clear and ready a means of doing this that our only wonder is that the instrument was not invented long ago. The plan pursued is somewhat similar to that previously described in the case of the Mechanical Globe, consisting of a globe, painted half white and half black, rotating in a circular aperture in a square blackboard. The position of the sun is given by a brass ball, revolving by means of a wire framework round the central globe; and the only inaccuracy we can detect in the whole instrument is that in the specimen now before us for our examination the brass ball representation of the sun is not placed sufficiently high to correctly define its position with respect to the lit-up portion of the lunar surface. In good hands the Selenotrope, like the Mechanical Globe, can hardly fail to be of good service.

Free England; or, Old Stories of the English Parliament. By H. E. B. London: Jarrold and Sons, 3, Paternoster Buildings.

In the preface to this beautiful little volume, the writer says that it is not intended so much for schoolroom use as with the hope that here and there some schoolboy taking it up of his own accord may find a pleasure in these stories of England's liberties. We are of opinion, however, that it would be very difficult to find a more suitable volume to place in the hands of our elder boys in school, as well as those about to enter upon work, to give them a desire for studying such things as will fit them for their own future duties as good citizens. As a reader for the sixth and seventh standards, or as a prize book to boys leaving school, the book is equally suitable.

In ten chapters, with upwards of twenty subdivisions, the writer, in admirable language, tells the story of the struggles for constitutional liberty in this country. Beginning with 'The Barons and Magna Charta,' the several stages in the contest are marked as follows: 'Simon de Montfort, the Founder of the House of Commons,' 'Edward I. and the Shaping of the English Constitution,' 'Sir John Eliot and the Petition of Right,' 'John Hampden and the Great Rebellion,' 'The Revolution of 1688,' 'William Pitt,' 'The Abolition of the Slave Trade,' 'Catholic Emancipation,' and 'The Reform Bill.'

Each of these chapters is thoroughly well written, and the story of the various battles and triumphs in the cause of freedom is made quite as interesting as a novel.

In the Blue Book for 1882, one of Her Majesty's Inspectors said, 'Less time might well be given to the mere committal to memory of strings of battles and dates, and more attention paid to the study of noble lives and characters, and the gradual development of our laws and constitution.'

Both these points are attended to in the volume before us, and it has our heartiest approval, for writer, printer, and publisher have all combined to produce an interesting and beautiful book.

The Teachers' Diary and Pocket Book. London: Jarrold and Sons.

To this excellent idea, admirably carried out, we give our heartiest approval. This, the third yearly issue, is a distinct advance upon any of its predecessors, yet without increasing the bulk of the book. Among the new matter which the present issue contains will be found the latest alterations in the Code, the revised instructions to Inspectors, the new needlework exercises for the examination day, forms on which to tabulate the results of test examinations in each standard, the entrance fees at the various training colleges, and a calendar for 1886, which will be of service to many teachers in calculating the commencement of the last twenty-two weeks of the school year. We can confidently and cordially recommend it to every English elementary teacher.

Charity Moore. By Lina Ormon-Cooper. With illustrations by T. Pym. London: Hodder and Stoughton.

It is difficult to understand with what object such books as this—for 'Charity Moore' is but one of a large class—are written. Their matter and manner are as ill-suited to boys and girls as to very young children; their maudlin sentiment and false morality are obnoxious; their 'religion' must be positively painful to any sincerely religious mind. Long death-bed repentances and 'truly Christian deaths'—both favourite themes—are neither pleasant nor suitable reading for young children. Why this constant harping upon death? The children will learn all too soon the meaning of death, the bitterness of loss, the pain of parting from the beloved. Meantime, if we must speak to our children of death, to them, at least, let it mean nothing but a long, sweet sleep, the longest, calmest, sweetest sleep of all. If the writers of these so-called 'religious' stories would but remember the words, 'Suffer little children to come unto Me,' the tenderness of them would be a lesson and a warning. They would then no longer try to make small children sad and ludicrous caricatures of their elders; they would no longer attempt to make the fresh, young minds like those of the older and less pure; they would, in speaking to little children, strive to become as 'one of these,' and not force the little ones to become like unto themselves.

Charity Moore is a little girl who has been left by her father at a workhouse, when only six weeks old. She manages one day to save a little girl from being run over, and is thereupon taken as nursemaid by the mother of the little girl. Then Charity passes through a variety of adventures, always with the same self-conscious air of superior virtue that is very irritating. In the end she marries an elderly admirer. But before this final reward of virtue, her father, of course, turns up. He is drunk and dissolute, and Charity, having been abandoned by him when a baby, of course feels it incumbent upon her to abandon in turn her lover, her friends, and her home, to go with her parent. This sense of duty does not, how-

ever, prevent her from writing to her lover after her father's death—(and the preaching to the dying man by his daughter is particularly objectionable)—that 'father has gone home *at last*, now I am ready to come to you.' There is an exultation about that 'at last' which is hardly pleasant.

There are various passages in this little volume which we feel bound to denounce very strongly. To tell small children that 'quite often mothers leave their babies,' *i.e.*, at the workhouse, 'when they are ashamed of them,' is surely unnecessary. It is bad enough to think that some day children will know that mothers *can* be driven into being ashamed of their own children, without forcing this knowledge upon them. Nor do we think it well to call the attention of little ones specially to certain passages in the Old Testament, as Miss or Mrs. Cooper does.

We would also earnestly advise Mrs. Cooper, who finds her English quite as much as she can manage, not to attempt French. 'Je *vive* en espoir,' even supposing she had not made the slip in her verb, would still be un-French—a mere putting into French words of an idiomatic English phrase.

The book is nicely got up, so nicely that we wish its contents were worthy of its binding and printing; and the illustrations, albeit the illustrator forgets sometimes which of the heroines is dark and which is fair, and consequently gets them a 'little mixed,' are pretty enough.

Guide Book for Pupil Teachers. By James Beveridge. London and Edinburgh: W. and R. Chambers.

This is simply a reprint of two years' papers set for candidates and first year pupil-teachers in Scotland, with about a dozen solutions of questions in arithmetic and analysis. It will be useful in Scotch schools, where candidates for apprenticeship are still examined separately, but will not serve as a guide to the work in English schools, the codes of the two countries not being alike. It is well printed, and the answers to the four hundred questions in arithmetic are appended.

Paragon Readers. IV. and V. Manchester: John Heywood.

Both these volumes maintain the excellence of the earlier numbers in the series. They are well bound, clearly printed, and suitably illustrated. The matter in both volumes has been skilfully chosen, for while well-tried fields of literature have been gleaned from, an unusually large number of pieces, especially in the Fifth Reader, are such as are not usually found in school books. Modern writers, as Macaulay, Speke, Washington Irving, Scott, McCarthy, and others, have been laid under contribution; the whole selection reflecting much credit upon the editor of the series. Teachers will find them very suitable for their respective standards.

The 'E.S.A.'s' Test Cards. Standards II. to VII. London: The Educational Supply Association, Limited, Holborn Viaduct.

Another set of test cards under the above title is presented for approval.

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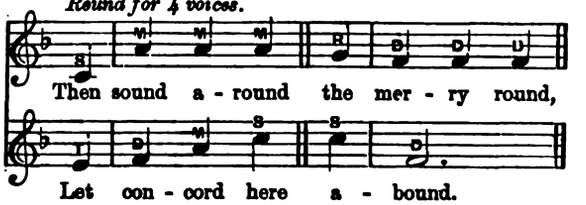

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